Brazos County
Engineering Design Guidelines

EFFECTIVE DATE: July, 2019

RESOLUTION & ORDER

These Design Guidelines shall be known as the Brazos County Engineering Design Guidelines ("Design Guidelines"). This document supersedes all previous versions of design guidelines within the Brazos County Subdivision Regulations adopted prior to July 5, 2016.

These Design Guidelines, as well as required review fees as itemized in the Fee Schedule in Appendix B of the Brazos County Subdivision Regulations, shall apply to all new Applications received on or after the date these Design Guidelines were adopted by the Brazos County Commissioner's Court. Any Applications that were originally submitted prior to that date shall be subject to the Design Guidelines that were in effect at the time of the original submission.

Compliance with these Design Guidelines shall be a prerequisite to the approval of any subdivision and/or construction project by Brazos County, except insofar as they may conflict with any applicable state statute.

ACKNOWLEDGEMENTS

The following individuals contributed to the preparation and adoption of these Engineering Design Guidelines:

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TABLE OF CONTENTS

ARTICLE 1. GENERAL PROVISIONS

101. General Information.

101.1 Purpose.

It is the intent of these general Design Guidelines of Brazos County, Texas, to state the requirements for subdividers, developers, engineers, surveyors, realtors, and other persons interested and involved in the development of land. Furthermore, it is the intent, purpose, and scope of these Design Guidelines to promote and protect the health, safety, and general welfare of the public.

Presented herewith are the general requirements of the Road and Bridge Department for designing drainage facilities, paving, waterlines, and sanitary sewerlines within Brazos County. These requirements are the general guidelines to inform the design engineers and contractors performing work in Brazos County of the Department's policies and procedures. In no way does the following information provide all answers to design and construction questions or situations; however, it does provide a means to initiate the design and construction of facilities in the manner utilized by the Brazos County Road and Bridge Department.

The design of any public utility or paving must be approved by the respective Utility Provider and/or the County Engineer prior to construction authorization. The construction of all public utilities and street paving shall be approved by the respective Utility Provider and/or the County Engineer before final acceptance and maintenance.

101.2 Authority.

These Design Guidelines are adopted under the authority of the Constitution and laws of the State of Texas, including particularly:

1. Texas Local Government Code:
    a. Chapter 232, County Regulation of Subdivisions;
    b. Chapter 242, Authority of Municipality and County to Regulate Subdivisions In and Outside Municipality's Extraterritorial Jurisdiction; and
    c. Chapter 245, Issuance of Local Permits.
2. Texas Transportation Code:
    a. Chapter 251, General County Authority Relating to Roads and Bridges;
    b. Chapter 252, Systems of County Road Administration;

c. Chapter 253, County Improvement of Subdivision Roads;

d. Chapter 254, Drainage on Public Roads; and

e. Chapter 255, County Regulation of Sight Distances.

102. Definitions of Terms and Abbreviations.

102.1 Definitions of Terms and Abbreviations.

1. **ACI**
   American Concrete Institute.

2. **AI**
   The Asphalt Institute.

3. **Alley**
   A narrow public or private right-of-way which provides a secondary means of vehicular access to abutting property and not intended for general travel.

4. **ANSI**
   American National Standards Institute.

5. **ASTM**
   American Society for Testing Materials.

6. **BCS Unified Design Guidelines**
   Engineering design guideline document produced jointly by the Cities of Bryan and College Station Texas.

7. **Contract**
   The agreement between the developer and the contractor covering the furnishing of materials and performance of the work. The directions, provisions, and requirements contained herein or in special specifications, supplemented by such special provisions as may be issued or made pertaining to the method and manner of performing the work, or to quantities and quality of materials.

8. **Contractor**
   The individual, firm, or corporation or any combination thereof, with which the contract is made by a developer or the County. The work shall include the furnishing of all labor, materials, equipment, and other incidentals necessary or convenient to the duties and obligations imposed by the contract.

9. **CRSI**
   Concrete Reinforcing Steel Institute.

10. **Lip of Gutter**
    Lip of Gutter; the front edge of the curb. The point where the curb meets the roadway pavement.

11. **Specifications**
    The directions, provisions, and requirements contained herein or as may be issued or made pertaining to the methods and manner of performing the work or quantities and qualities of materials to be furnished. Where reference is made to specifications of ASTM, AASHTO, AWWA, ANSI, or bulletins and manuals, it shall be construed to mean the latest standard or tentative standard in effect.

12. **Survey**
    A boundary or topographic map.

13. **Travel Way**
    The portion of a road or roadway intended for vehicular travel. Where concrete curb is installed, the travel way shall be measured Lip of Gutter (LOG) to LOG. In cases where a ribbon curb is installed, the travel way shall be measured from the inside edge to the inside edge of the ribbon curb (i.e., the ribbon curb is not included as part of the travel way). The travel way also does not include gravel or paved shoulders.

14. **Utilities**
    Facilities for public use, i.e., water, wastewater, and drainage, gas, telephone lines, electricity, cable television, etc.

103. Scope of Work.

103.1 Intent of Plans and Specifications.

It is the intent of plans and specifications submitted to the County for review to describe a complete work to be performed.

103.2 Changes and Alterations.

All changes and alterations in the plans and specifications must be prepared by the Engineer and approved by the County Engineer.

104. Control of Work.

Many new road, drainage and utility construction projects within Brazos County are performed by commercial and residential property developers. These constructed roadway, drainage and utility

networks are intended to be conveyed to the County at the time of acceptance and turned over to the County for operation and maintenance. These facilities frequently represent significant additions to Brazos County's maintenance and operational responsibilities. The establishment of adequate quality control procedures for these types of projects is extremely important because the County is not able to exercise day-to-day control of the work.

104.1 Authority and Duties of Engineer.

The Engineer shall provide for inspection, sampling and testing necessary for day-to-day job control. The Engineer or his representative shall inspect all work performed and all materials furnished to the project and bring any deficiencies in work or materials to the attention of both the Contractor and the County.

The Engineer shall see that all sampling and testing required by specifications or job site conditions, are performed by an independent Material Testing Laboratory. He shall also issue a letter of certification, at the completion of the work, acknowledging that the project was constructed in accordance with County approved plans, specifications, and special provisions.

104.2 Authority of Road & Bridge Department.

The Road & Bridge Department's representative will decide all questions which may arise as to the quality or acceptability of materials furnished and work performed, the manner of performance, the interpretation of the County's construction requirements, and the acceptable fulfillment of the Developer/Contractor's obligations.

104.3 Authority and Duties of County Inspector.

County inspectors will be authorized to inspect the work done and all materials furnished. A County Inspector will be assigned to the work by the Road & Bridge Department and will report to the Road & Bridge Department as to the progress of the work and the manner in which it is being performed, also to report whenever it appears that the material furnished and the work performed by the Developer/Contractor fail to fulfill the requirements of the specifications and to call attention of the Contractor to any such failure or other infringement. Such inspection will not relieve the Developer/Contractor from any obligations to perform the work in accordance with the requirements of the specifications. In case of any dispute arising between the Developer/Contractor and the Inspector as to materials furnished or the manner of performing the work, the Inspector will have the authority to reject materials or suspend work until the question at issue can be referred to and decided by the Road & Bridge Department. The Inspector will not be authorized to approve or accept any portion of work. He will in no case act as foreman or perform other duties for the Developer/Contractor. The place, frequency and thoroughness of inspection will vary depending of the construction activity and the quality of work exhibited by the construction organization. The presence of a County Inspector does not relieve the Engineer of his inspection responsibilities.

104.4 Cooperation of Contractor.

The Contractor shall give the work his constant attention to facilitate the progress thereof and shall cooperate with the County and the Engineer in every way possible. He shall have at all times a satisfactory and competent superintendent on the work site.

104.5 Bond or Cash Deposit for Unsatisfactory Repairs or Damages

It will be the responsibility of the Contractor to put up a bond or cash deposit in the amount affixed by the County Engineer to cover any damages incurred to County-maintained facilities or authorized franchise utilities during construction.

105. Control of Materials

105.1 Quality of Materials

All materials shall be new and of a quality conforming to the requirements of these specifications. Whenever the quality or kind of materials is not particularly specified, the materials shall be of the best grade in quality and workmanship obtainable in the market from firms of established good reputation.

105.2 Samples and Test

All properly installed materials, before being incorporated in the work, shall be inspected, tested, and approved. Subject to the approval of the Road & Bridge Department, pre-tested sampling and testing will be provided at the developer's expense, by a materials-testing firm approved by the Road & Bridge Department. All tests of materials shall be made in accordance with the County specifications and recognized practices.

105.3 Storage of Materials

Materials shall be stored and protected in accordance with manufacturer's recommendations to insure the preservation of their quality and fitness for the work.

105.4 Defective Materials

All materials which do not conform to the requirements of the County specifications shall be considered as defective, and all such materials, whether in place or not, shall be rejected and immediately be removed from the site of work, unless otherwise permitted by the Road & Bridge Department. Rejected materials, the defects of which have been subsequently corrected, shall have the status of new materials, as approved by the Road & Bridge Department.

105.5 Hauling of Materials

Any vehicle, truck, truck-tractor, trailer or semi-trailer or combination of such vehicles, when used to deliver materials to a project shall comply with the State and City laws concerning gross weight and load limits. Special haul routes for construction traffic may be designated by the Road & Bridge Department within the unincorporated portions of Brazos County. The Developer/Contractor is responsible for the protection of all existing roads and small structures traveled by his material haulers.

Any damage by the use of construction equipment shall be restored to its original condition or replaced at the Contractors/Developers sole expense. (See 104.5 above)

106. Legal Relations and Responsibilities to The Public

106.1 Laws to be Observed.

The Developer/Contractor shall make himself familiar with and at all times shall observe and comply with all Federal, State, and Local laws, ordinances, and regulations which in any manner affect the conduct of the work and shall indemnify and save harmless the County and its representatives against any claim arising from the violation of any such law, ordinance, or regulations, whether by himself or by his employees.

106.2 Permits, Licenses, and Taxes

The Developer/Contractor shall procure all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the due and lawful prosecution of the work.

106.3 Sanitary Provisions

The Developer/Contractor shall, at his entire expense, provide and maintain in neat, sanitary conditions such accommodations for the use of his employees as necessary to comply with the requirements and regulations of the State Department of Health or of other authorities having jurisdiction.

106.4 Public Safety and Convenience

The safety of the public and the convenience of traffic shall be of primary importance. Unless approval has been given by the Road & Bridge Department, all portions of a roadway shall be kept open to traffic. It shall be the Contractor's entire responsibility to maintain and/or provide ingress and egress to adjacent private property. The Contractor shall plan and execute his operations in a manner that will cause the minimum interference with traffic. The Contractor shall secure the Road & Bridge Department's approval of his proposed plan of operation, sequence of work, and methods of providing for the safe passage of traffic before it is placed into operation. If at any

time during construction, the approved plan does not accomplish the intended purpose due to weather or other conditions affecting the safe handling of traffic, the Contractor shall immediately make necessary changes therein to correct the unsatisfactory conditions. All equipment and materials shall be stored in such a manner and at such locations so as not to interfere with the safe passage of traffic. If in the opinion of the Road & Bridge Department the above requirements are not complied with, the Road & Bridge Department may direct such work as he may consider necessary, however, this shall not change the legal responsibilities. The expense for such work performed by the County will be borne by the Developer/Contractor.

106.5 Barricades and Danger, Warning, Detour Signs, and Traffic Handling

The Contractor shall have the sole responsibility for providing, installing, moving, replacing, maintaining, cleaning, and removing upon completion of the work all barricades, warning signs, barriers, cones, lights, signals, and other such type devices, and the handling of traffic. All barricades, warning signs, barriers, cones, lights, signals, and other such type devices shall conform to the Texas Manual of Uniform Traffic Control Devices for Streets and Highways, as amended.

106.6 Protection of Property.

The Developer/Contractor shall take proper measures to protect private and public property which might be injured or damaged by any process of construction; and in case of any injury or damage resulting from any act or omission on the part of or on behalf of the Developer/Contractor, he shall restore, at his own expense, the damaged property to a condition equal to or better to that existing before such injury or damage was done, or he shall make good such injury or damage in an acceptable manner.

106.7 Responsibility for Damage Claims

The Developer/Contractor agrees to indemnify and be responsible for all damages or injury to property of any character occurring during the prosecution of the work resulting from any act, omission, neglect, or misconduct on his or his agents part in the manner or method of executing the work; or from failure to properly execute the work; or from defective work or materials. The Developer/Contractor's attention is directed to the fact that the location of pipelines and other underground installations are not always exact. The Developer/Contractor shall save and hold harmless the County from any and all claims resulting from these responsibilities.

ARTICLE 2. GENERAL DESIGN PROCEDURES

201. Preliminary Research Requirements

Step one in the Preliminary Research Process is to contact all applicable County offices and discuss concepts outlining what is to be proposed and its usage. Depending on the location and size of development, the initial contact may be handled by phone or a meeting at the Road & Bridge Department. The Developer/Engineer should verify that no restrictions are existing that will deny the approval of the concept. The Developer/Engineer should research all existing utilities and right-of-way and easement information with the ETJ Authority (Respective City), State, County and other authorities whose approval will be necessary for the proper use of the development. The Developer/Engineer shall research all laws, ordinances, rules and regulations that may pertain to the development.

202. Preliminary Design Requirements

The Developer/Engineer shall provide the Road & Bridge Department with all maps, plans, and calculations to support the proposed design. These exhibits will not be considered unless they have been prepared under the direction of a Licensed Professional Engineer in the State of Texas. Sealed final plans by the responsible Engineer are required. All developments shall follow proper filing procedures through the City, County and comply with current regulations.

A preliminary report proposing processes, methods or procedures not covered by these Design Guidelines or a request for an exception to any portion of the Design Guidelines, shall be submitted during preliminary design. Concurrence, at this point, between the Developer/Engineer and the Road & Bridge Department regarding the essential design data is desired to eliminate delay or inconvenience and to avoid the likelihood of having to re-design the detailed final plans.

203. Final Design Requirements

Final design requirements involve the review of detailed construction drawings to insure that all proposed facilities are designed in accordance with all applicable regulations. All plans and specifications submitted for final review must be sealed and dated by a Licensed Professional Engineer in the State of Texas.

Developer/Engineer shall submit adequate, complete prints of plans for feasibility, preliminary and final review to the Brazos County Engineer. Planning material submitted shall in all instances be in such detail as to permit a comprehensive review.

204. Plan Submittal Requirements

The following is a guideline of requirements for plan submittals to Brazos County; plans shall be submitted in 24”x36” print media and will consist of but not be limited to:

1. Two (2) sets of construction plans as described in Section 302.

2. Accompanying documents:

    a. TxDOT approvals for driveway and drainage into their jurisdiction (if applicable);

    b. Pipeline company approvals on pipeline letterhead (if applicable);

    c. Storm Water Quality Management Plan and Permit;

    d. Engineer's Cost Estimate;

    e. An Engineer's Summary Letter shall be submitted outlining the nature of the project and any requests for the use of other standards from the design standards with justification for such applications.

    f. Traffic Impact Assessment (if applicable); and

    g. If County provided pavement designs shown in Section 405 are not utilized, provide one copy of the geotechnical report establishing pavement design standards based on AASHTO pavement thickness design for a full 20-year life and all pavement design calculations.

205. Final Plan Approval

Approval from all governmental agencies, all utility providers, and respective City with ETJ Authority must be obtained prior to final plan approval.

All developments shall conform to the Brazos County's current regulations.

All easements and rights-of-way required for the construction of a proposed project must be accepted and approved by all applicable governing entities, and filed for record with Brazos County.

206. "As Built" Requirements

When the work provided for in the approved plans and specifications has been satisfactorily completed, "As Built" plans will be required to replace the approved plans that are on file at the Brazos County Road & Bridge office. These plans shall be labeled "As Built" and certified and dated by the Contractor.

Contractor As-Built Set Certification:

I, _____, General Contractor for _____, certify that the improvements shown on this sheet were actually built, and that said improvements are shown substantially hereon. I hereby certify that to the best of my knowledge, that the materials of construction and sizes of manufactured items, if any, are stated correctly hereon.

_____ (General Contractor)

Engineer As-Built Drainage Certification:

"I hereby attest that I am familiar with the approved drainage plan and associated construction drawings and, furthermore, attest that the drainage facilities have been constructed in accordance with the Brazos County Engineering Design Guidelines and in accordance with the approved construction plans or amendments thereto approved by Brazos County Road & Bridge. Furthermore, we attest that any public or private detention pond constructed with the project is built within dimensional tolerances specified in the Brazos County Engineering Design Guidelines and in accordance with the approved construction plan or amendments thereto."

_____
Licensed Professional Engineer

State of Texas No._____

An electronic set of the final as-built plans will be required to be submitted to the Brazos County Road & Bridge's office for future reference.

All public facilities shall be shown to be located within public rights-of-ways or appropriate easement.

ARTICLE 3. GENERAL DESIGN AND PLAN REQUIREMENTS

301. Survey Requirements

The following guidelines are suggested for use by Engineers in the development of plans. The intention of these requirements is to provide all the evidence available for the proper location of improvements within functional and legal boundaries. All survey activity shall be performed under the direction of a qualified professional and in accordance with Texas Society of Professional Surveyors Manual of Practice and TxDOT Survey Manual.

301.1 Field Work Required for Plans

Field Work Required for Plans. The transit or base line must be monumented at its beginning, end, and at all angle points with markers of a permanent nature. Monuments shall be set on long lines at intervals not to exceed 1000 feet.

The existing right-of-way monuments or property corners that are found must be plainly shown on the plans and located by station and distance, “Right” or “Left” from the transit line or construction center line. Those monuments that were used to determine the construction center line, must be identified as “control points”, and their relationship to the construction center line and to proposed or existing right-of-way lines must also be shown.

NAVD 88 vertical datum must be used for elevations, and the complete numerical designation of the monuments must be identified on the plans, as well as the year of the datum of the monuments must also be identified on the plans. NAD 83 horizontal datum must be used on all projects. All monumentation shall be referenced and tied to a survey control monument as provided in the Brazos County Survey Monument Report (2014).

Plans must show centerline angles of intersections of side streets with the main roadway and the centerline station on the main roadway. Where bearings are used, care should be taken so that bearings are shown on both base line and constructions center line. The source of the bearings shall be clearly stated.

All topographic features within the right-of-way must be shown. The topography on intersecting streets shall be shown twenty feet beyond the intersection of the right-of-way lines.

Where plans identify proposed utility lines, the location of manholes, service connections, angle points, valves, fire hydrants, bends, etc. must be identified by station and distance from transit or base-line with relationship to the right-of-way lines.

All existing pipelines, utilities, and other features that may conflict with design shall be field verified for actual location.

All cross sections taken will be made at intervals not to exceed 50 feet. Elevation shots shall be taken on the centerline of all driveways at approximately the existing or proposed right-of-way line.

301.2 Right-of-Way Maps

All maps shall be sealed, dated and signed by a Texas Registered Public Surveyor.

302. Construction Plan Set Requirements

1. All construction plan sets shall consist of the following sheets, if applicable:

    a. Cover sheet with vicinity map, sheet index, signature block and preconstruction meeting note.

    b. Construction and or general notes;

    c. Overall project or site plan layout sheet;

    d. Topographic survey sheet(s);

    e. Final Plat;

    f. Typical Road Sections;

    g. Road Plan & Profiles (w/horizontal and vertical curve data);

    h. Paving Plan;

    i. Striping and Signage Plans;

    j. Traffic Control Plan;

    k. Overall Drainage and Grading Plan Layout;

    l. Culvert Plan and Profiles;

    m. Stormwater Pollution Prevention Plan;

    n. Utility Layouts;

    o. Utility Plan and Profiles (water, sanitary, storm), if applicable;

    p. Detail Sheets;

    q. Specialty Sheets as needed; and

r. All plans shall show a Project Benchmark and be tied into a Survey Control Monument as provided in the Brazos County Survey Monument Report (2014).

303. Graphic Requirements

1. All plans shall be prepared using Autocad. Plans shall be prepared on a standard sheet size of 24" X 36".

2. The seal, date, and original signature of a Licensed Professional Engineer in the State of Texas are required on each sheet.

3. Name, address, telephone number and email address of the professional individual or firm responsible for the preparation of the plans.

4. County boundaries, city limits, and subdivision section and/or phase boundaries.

5. A cover sheet shall be required for all projects involving three or more sheets. All plan sheet numbers should be included on the cover sheet or area key map. A vicinity map should always be included to show the project location. For Public projects, add the note "A PRE-CONSTRUCTION MEETING WITH BRAZOS COUNTY ROAD & BRIDGE IS REQUIRED AT LEAST 10 WORKING DAYS PRIOR TO ON SITE CONSTRUCTION ACTIVITIES. CALL (979) 822-2127 FOR A MEETING DATE AND TIME. A PRE-CONSTRUCTION MEETING FOR THIS PROJECT MAY NOT BE SCHEDULED AND CONSTRUCTION OF THE PROJECT MAY NOT COMMENCE PRIOR TO WRITTEN APPROVAL OF THESE PLANS BY THE BRAZOS COUNTY ROAD & BRIDGE DEPARTMENT."

6. A copy of the final plat should be included with the final plans when the design drawings are submitted for final approval.

7. Key overall layouts may be drawn at a scale of 1" = 100'. Major thoroughfares or special intersections/situations plan and profile should be drawn at a scale of 1" = 2' vertical; 1" = 20' horizontal and plan. Minor streets and easements plan and profile should be drawn at a scale of 1" = 5' vertical; 1" = 50' horizontal and plan, or 1" = 4' vertical; 1" = 40' horizontal and plan.

8. Details of special structures and standard details, such as stream and gully crossings, special manholes, etc., should be drawn with the vertical and horizontal scales equal to each other.

9. Temporary benchmarks and project datum shall be described on each sheet.

10. The construction plans shall indicate the location of the 100-year floodplain (as determined by the results of an engineering study or as established by FEMA).

11. A benchmark shall be established and indicated on the construction plans. The location, description and elevation of the benchmark are required to be identified within the construction plans. The elevation of this benchmark shall utilize the same vertical datum as that used in the engineering study or FEMA as applicable.

12. Label each plan sheet with road names, road widths, right-of-way widths, pavement width and thickness, type of roadway materials, curbs, intersection radii, curve data, stationing, existing utilities type, location, etc.

13. Stationing must run from left to right, except for short streets or lines originating from a major intersection where the full length can be shown on one single plan and profile sheet.

14. A north arrow is required on all sheets and should be oriented either upward or to the right. It is the intent of this requirement that all stationing should start from cardinal points of the compass and proceed in the direction of construction.

15. Show all lot lines, property lines, right-or-way lines, and easement lines.

16. If a roadway exists where plans are being proposed to improve or construct new pavement or to construct a utility, this roadway should be labeled as to its existing width, type of surface, and base thickness.

17. All utility lines within the right-of-way or construction area should be shown in the profile view. All utility lines, regardless of size, should be shown in the plan view.

18. Show flow line elevations and direction of flow of all existing ditches.

19. Show natural ground profiles and proposed ditch flowline at each ditch centerline.

20. The diameter and length for each culvert shall be labeled on the construction plans. A plan and profile for each culvert shall be provided.

21. Resolve all construction conflicts of proposed utilities and facilities with existing or future utilities or facilities.

22. If the roads within the Subdivision will be private, a sign shall be placed at the entrance of the Subdivision clearly stating that the roads in the Subdivision are privately maintained roads. The location of this sign shall be shown on the construction plans.

23. All street and/or road alignments shall be shown on plans. Plans shall be drawn to accurate scale, showing proposed pavement typical cross section and details, lines and grades, and all existing topography within the street right-of-way; and at intersections, the cross street shall be shown at sufficient distance in each direction along the cross street for designing adequate street crossings.

24. Centerline grades are acceptable for paving without curbs and gutters. Curb return elevation for decel/accel lanes shall show in the profile. Grades should be labeled for the top of the curb except at railroad crossings. Gutter elevations are required for vertical curves where a railroad track is being crossed.

25. Centerline length of each road in the proposed subdivision and its design speed shall be indicated on the construction plans.

26. The surface elevation at the property line of all existing driveways should be shown in the profile.

27. The design of both roadways is required on all pavement sections with a median. Station all median noses, both existing and proposed.

28. Station all P.C.'s, P.T.'s, radius returns, and grade change P.I.'s in the profile with their respective elevations.

304. General Utility Locations

No utilities shall be placed in the street rights-of-way, but shall be placed in utility easements provided for that purpose; except that with a one-hundred (100) foot Right-of-Way or greater this provision may be waived by Commissioner's Court.

All other utilities; electric, gas, communications, and cable TV should be located in perimeter lot easements and back-to-back lot easements wherever possible. These utilities shall not be located in a public right-of-way or a specified easement, prohibiting its use, without the approval of the Brazos County Road & Bridge Department. The locations of these utilities within general utility easements shall be in accordance with the guidelines stated below.

For all new developments that have less than one-hundred (100) feet of right-of-way, all utilities shall be installed within a public utility easement located outside of the dedicated right-of-way.

If approved by Commissioner's Court, utilities in all new developments that have 100 feet or greater of right of way shall be installed within designated locations based upon the type of utility. The location shall be as follows: (measured from back of right-of-way, and accommodated within the right-of-way).

- Power – 0-2 feet, nominally 1'
- Phone – 2-4 feet, nominally 3'
- Gas – 4-6 feet, nominally 5'
- Cable – 6-8 feet, nominally 7'

All underground installations shall (these are minimum depths – utility may place deeper):

- Be placed at a minimum depth of forty-eight (48) inches below the top of the pavement;
- Be at least thirty-six (36) inches below ditch flow line when installation is within the area measured from top of bank to top of bank;

- Be at least forty-eight (48) inches below ditch flow line if low pressure gas or petroleum lines. For high pressure gas and petroleum lines, a depth of 60" below ditch flow line. Verification from the pipeline company is required to assure depth is sufficient to meet their requirements.

305. Easement Requirements

Easements shall be provided for all drainage and utilities per the easement requirements outlined in the most current Brazos County Subdivision Regulations, Article 7.

305.01 Slope Easements

In the case where a road is constructed with significant cut or fill wherein the required 4:1 slope extends beyond the dedicated Right-of-way then a slope easement shall be required. This slope easement shall be a minimum 16 feet in width adjacent to and outside of the right-of-way to protect the 4:1 slope from being encroached upon by a private retaining wall.

ARTICLE 4. ROAD DESIGN (Pavements and Geometrics)

401. General

Standards established by Brazos County for the design and construction of its roads shall provide for pavements with long service life and low maintenance. Excess maintenance of inadequate pavements is an unnecessary drain on tax dollars. An investment in adequately designed and constructed roads needing little maintenance over a long service life frees more dollars for capital improvements necessary to serve the community.

Pavements are designed for both economy and long service. The Engineer shall take into consideration the road classification and traffic which will include the axle weights and volumes, thickness design, surface material quality, base material quality, sub-grade material quality, geometric design, and jointing.

Standards of this publication shall be considered minimum for any specific location and the Engineer should base his design upon the actual conditions which exist within the development under consideration for design.

Provisions must be made for the uninterrupted extension of main thoroughfares as shown on the Bryan-College Station Metropolitan Planning Organization (BCSMPO)'s Thoroughfare Plan and/or the City of Bryan or City of College Station Thoroughfare Plans as applicable. In the case of disagreement between the plans, the County Engineer shall provide clarification. Roads must provide for free circulation within developments and interconnectivity to adjacent developments.

402. General Information

The County Engineer will review all plans for construction or upgrading of streets or roads in the County Road System to include, but not limited to:

1. New construction
2. Staged development of roadways (overlays)
3. Roadway widening
4. Appurtenant roadway improvements such as storm drains and curb and gutter
5. Encroachments

To be eligible for acceptance into the County Road System, a street or road must be designed and constructed in accordance with these standards and approved by the County Engineer. In general, roadways should be designed for the anticipated traffic volume twenty (20) years from the proposed date of construction. Special conditions such as long range planning studies, industrial parks, proposed interstate facilities, etc. should be considered in the design.

403. Roadway Design Standards

403.01 Design Standards

Design standards, unless specifically identified, shall be standards that are found in common usage by the Texas Department of Transportation. Design guidelines shall conform to the formulae, principles, and guidelines set forth in *A Policy on Geometric Design of Highways and Streets*, latest edition, as developed by the *American Association of State Highway and Transportation Officials (AASHTO)*. All references to "mountainous terrain" shall not apply to the County.

1. Roadway Classifications

   Roadways shall be classified based on the criteria established in *A Policy on Geometric Design of Highways and Streets*. For the purposes of these Regulations, roadways shall be designed to handle the average daily traffic (ADT) estimated to occur for a period of twenty (20) years following completion of construction of the roadway, with the pavement sections and widths required to accommodate the design ADT at the applicable speed limits adopted by the County.

   At a minimum, pavement sections and widths shall conform to the suggested minimum requirements established by AASHTO for the specified classification of roadway or to those shown in Table 4.1 for the specified classification of roadway.

   a. Major Arterials provide a high degree of mobility by serving travel between major destinations or activity centers, as well as long distance travel that goes through or bypasses an area. They are designed to minimize travel time by providing high posted speed limit, offering physical separation from other roadways and limiting access points. Major Arterials shall meet the following requirements.

      (1.) In order to promote the movement of traffic on arterial streets, the spacing of signalized street intersections on major roads shall not be less than 2,600-feet unless approved by the Commissioners Court. In general, the spacing of street intersections along an arterial shall not be less than 1,300-feet, unless sight -distance or topography dictates a lesser street spacing. Medians may be required along major roads where street intersection spacing is less than 1,300-feet, or driveway spacing is less than 200-feet. Median breaks shall be located at intersections with arterials, collectors, industrial streets, and driveways to major traffic generators. Additional driveway spacing requirements can be found in Section 408.

      (2.) Required right-of-way and pavement widths shall be as shown in the BCSMPO's Thoroughfare Plan or based on projected traffic volumes and street capacity as detailed in a traffic study prepared by a qualified traffic engineer, or as shown on Table 4.1. All rights-of-way and pavement width shall be approved by the Commissioners Court.

(3.) Geometric design shall conform to the formulas, principals, and guidelines of *A Policy on Geometric Design of Highways and Streets*. All elements including geometric layouts and cross-sections shall be approved by the County Engineer on a case by case basis.

b. Minor Arterials are intended to connect traffic into and between the principal arterial system and serve trips of moderate length by connecting smaller geographic areas. While they provide slightly less mobility than Major Arterials, overall they are characterized by relatively high travel speeds and low interference from cross traffic. Minor Arterials shall be extended to adjacent undeveloped property as approved by the Commissioners Court upon consideration of future circulation needs of the area.

c. Collectors provide a balance between mobility and access, primarily serving to collect traffic from local roads and provide connections to Arterials. Collectors usually serve moderate traffic volumes. There are typically few discernible differences between collectors and local roads within a neighborhood because they provide access to adjacent residential and nonresidential lots. Collectors should be designed with the most favorable alignment and cross section practical. Collectors shall be extended to adjacent undeveloped property as approved by the Commissioners Court upon consideration of future circulation roads of the area.

d. Local roads and streets are any public road/street not designated as a major thoroughfare, freeway, or highway and not situated within the existing and/or planned pattern of streets in a manner to cause it to function as a collector. A local road/street should provide access to adjacent land over short distances. A local road/street primarily serves traffic within a neighborhood or limited residential district and is not continuous through several residential districts. The layout of residential streets shall consider the natural topography and deliberately discourage through traffic in neighborhoods. Local roads and streets make up the bulk of the transportation system in terms of mileage. The Commissioners Court may require that residential streets be stubbed out to adjacent undeveloped property in order to provide adequate circulation to adjacent tracts and ensure emergency ingress/egress.

e. Industrial streets are planned to provide vehicular access to industrial lots. Industrial streets shall be required to extend to adjacent undeveloped property as approved by the Commissioners Court upon consideration of future industrial developments and protection of future residential areas from truck traffic.

403.02 Design Requirements

Table 4.1 below summarizes roadway design requirements based on the roadway classification.

Table 4.1 Design Requirements Based on Roadway Classification

SUMMARY OF BRAZOS COUNTY ROAD STANDARDS - RURAL							
Average Daily Traffic (one-way trips)	0-1,200	1,201-3,000	0-3,000	0-5,000	3,001-5,000	5,001-15,000	>15,000
Functional Classification	Local Road	Minor Collector – Residential	Minor Collector – Industrial	Minor Collector - Commercial	Major Collector	Minor Arterial	Major Arterial
Design Speed	30 mph	30 mph	35 mph	35 mph	40 mph	45 mph	All elements including geometric layout and cross-section approved by the County Engineer on a case-by-case basis.
Number of Lanes	2	2	2	2	3	4	
ROW Width (Min)	70’	80’	90’	90’	100’	100’	
Width of Travel Lanes	12’	12’	15’	15’	12’ (with 14’ CTL)	12’	
Width of Shoulders	3’ Paved	3’ Paved	3’ Paved	3’ Paved	4’ Paved	4’ Paved	
Minimum Centerline Radius	300’	465’	675’	675’	675’	940’	
Minimum Tangent Length between Reverse Curves or Compound Curves	Super-elevation transition is to be accomplished 2/3 outside of the horizontal curve and 1/3 within the curve. The minimum tangent between successive horizontal curves should be designed such that proper super-elevation transitions can be effected.						
Minimum Radius for Edge of pavement at Intersections	25'	25’	35’	35’	35’	35’	
Intersection Street Angle	75-105	75-105	80-100	80-100	80-100	80-100	
Maximum Grade	6%	6%	5%	5%	5%	5%	
Minimum Stopping Sight Distance	200’	250’	305’	305’	305’	360’	
Minimum Intersection Sight Distance	Refer to the latest edition of AASHTO’s “A Policy on Geometric Design of Highways and Streets”.						
Ditch Front Slope	4:1 Max/6:1 Pref	4:1 Max/6:1 Pref	6:1 Max	6:1 Max	6:1 Max	6:1	
Ditch Back Slope	3:1 Max/4:1 Pref	3:1 Max/4:1 Pref	4:1 Max/6:1 Pref	4:1 Max/6:1 Pref	4:1 Max/6:1 Pref	6:1	
Minimum Cul-De-Sac ROW Radius	60’	N/A	N/A	N/A	N/A	N/A	N/A
Minimum Cul-De-Sac Pavement Radius	40’	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

1	Any deviation from these standards are subject to an approved written variance. Request must be made in writing.
2	Lots that are restricted by plat note to one single-family residence shall be presumed to generate 10 one-way trips per day. Average daily traffic for all other lots shall be determined from the most current edition of ITE Trip Generation Manual.
3	Occasional short runs between intersections may exceed the amounts shown with County Engineer Approval, but maximum grade through intersections may not exceed grades shown.
4	The entire side ditch shall be totally contained within the roadway ROW. In cases where this cannot be accomplished, the back slope of the ditch may be contained in a dedicated drainage easement. Guardrail may be required.
5	No cul-de-sac shall have a cross slope which exceeds 4% cross-slope.
6	All roads shall maintain a minimum height clearance of 20’.
7	See Article 9 of Brazos County Subdivision Regulations for Traffic Impacts Analysis Requirements.

1. Road Grades

    a. Minimum cross slope grade of normally crowned roadways shall be 2% with a maximum slope of 3%.

    b. Approach grades on an intersecting street should be limited to 3% for at least fifty (50) feet unless sight distances are in excess of the AASHTO design guideline minimum for stopping on a grade level, in which case the approach grades should not be greater than those shown in Table 4.1.

2. Roadside Drainage

    a. The minimum grade for roadside drainage ditches shall be 0.6%. Preferred ditch grade is 0.7%

    b. Roadside Design Details

        (1.) Roadside design details include rock riprap, safety end treatments for culverts, special design roadside ditches, retaining walls, etc.

        (2.) Rock riprap shall be used to control the erosive characteristics of drainage in roadside ditches. The rock riprap shall be designed to reduce drainage water velocity to an acceptable level and to prevent drainage water from encroaching on the driving surface. Rock riprap shall not project onto shoulder surfaces and shall blend into ditch lines so that normal roadside ditch maintenance is possible.

        (3.) Headwalls, catch basins or other culvert structures shall be designed in accordance with the drainage requirements of these specifications using TxDOT's Typical Construction Details. No headwall, wing-wall or other structural member shall protrude above the surface of the traveled roadway. Safety End Treatments shall comply with TxDOT standard safety end treatment details.

        (4.) All special design of roadside ditches, retaining wall, etc., requires the specific approval of the County.

        (5.) Intersections of Curbed Streets/Driveways with Uncurbed Roads Curbed to uncurbed street/driveway intersections shall be designed with appropriate concern for the interfacing of the differing drainage systems.

            (a.) Where a curbed street/driveway intersects a continuing uncurbed street, standard curb and gutter shall terminate at the property line or as necessary to allow drainage from the curbed street/driveway to enter the uncurbed street bar ditch without erosion to shoulder areas. Concrete riprap or mortared rock riprap may be required to protect the shoulder area.

(b.) Where an uncurbed street intersects a continuing curbed street, the curb line shall be cut and removed and a standard urban curb return shall be designed into the uncurbed street with the curb face at the ditch centerline of the uncurbed street. A concrete riprap transition shall be constructed to convey drainage out of or into the uncurbed ditch line. The concrete riprap transition may be eliminated for discharge into the uncurbed street from the curbed street if transition grades are less than 2% or if an inlet is located within one hundred (100) feet of the intersection. For drainage from uncurbed street into the curbed street, for grades less than 5% on the uncurbed street, two ditch rock filter dams at ten (10) feet and thirty (30) feet from end of curb return may be used in lieu of riprap transition.

(c.) Care shall be taken in the installation to match existing pavement. Curbed street crown will be full crown (unless cross spilling) to at least fifty (50) feet from curb end to assure flow of drainage enters bar ditch.

(d.) For a curbed street discharging into uncurbed street, surface drainage that has been carried by the curb and gutter from a point more than two hundred (200) feet distance from the intersection with the uncurbed street shall be removed by the use of inlets draining to the drainage pipe required at the intersection so as not to interrupt the flow of drainage in the bar ditch of the uncurbed street.

3. Design Characteristics

a. Design Speed

Design speeds are shown in Table 4.1. by roadway classification for use with the design guidelines.

b. Vertical Alignment

(1.) Changes in grades of over 0.8% shall be connected by vertical curves.

(2.) Vertical Curves: Minimum length (L) of vertical curves shall be one hundred (100) feet or shall conform to the formula:

$L = KA$, whichever is greater

where A is the algebraic difference in the tangent approach grades expressed as a whole number, and K is established in accordance with *AASHTO's A Policy on Geometric Design of Highways and Streets*, for sag and crest vertical curves, with credit given to the use of proper street lighting.

(3.) Special consideration shall be given to streets where the horizontal alignment, overhead obstructions, or the presence of cross traffic or other natural or man-made conditions exist such that stopping sight distance would become the controlling parameter as it relates to the determination of a minimum length of vertical curve.

c. Horizontal Alignment

(1.) Minimum centerline radii and minimum tangents between reverse curves are shown in Table 4.1.

(2.) Increased radius may be required where the street grades, street cuts, or other natural or man-made obstacles limit stopping sight distance on the curve to below that required by the design speed.

(3.) Superelevation may be used to control surface drainage and centrifugal forces, but not to reduce the minimum centerline radius.

(4.) Superelevation of roadways will only be required for Major Collector and Arterial type roadways requiring design speeds of forty (40) mph or greater. It will not be required for other roadway classifications unless otherwise directed by County Engineer.

(5.) Design for horizontal curves including stopping sight distance and superelevation shall conform to the formula, principles, and guidelines of *AASHTO's A Policy on Geometric Design of Highways and Streets*.

d. Medians

(1.) Raised medians are not allowed on County roadways unless the roadway is classified as a minor arterial or above on the BCSMPO's Thoroughfare Plan.

(2.) Natural or planted medians separating opposing traffic lanes of an arterial are acceptable only if the pavement design is a rigid pavement design. Barrier type curbs or adequate lateral clearance must be provided on the median.

(a) Median Openings: The minimum number of median openings required to serve abutting property are to be provided. Care should be taken to locate openings only where there is adequate sight distance.

(b) Left Turn Lanes: On arterials, left lanes are to be provided at all median openings and intersections. The length of the turn lane is to be such that adequate storage under the expected peak traffic loading is provided. The minimum storage length however is one hundred and fifty (150) feet. Adequate tapper length shall be provided based upon design speed.

e. Islands: Natural or planted islands may not be used in the center of cul-de-sacs on residential and rural roads.

f. Cul-De-Sacs: All permanent dead-end streets are to terminate in a paved turnaround with a minimum paved radius and right-of-way radius as shown in Table 4.1.

g. Corner Sight Distance: all roadways are to be designed so that adequate corner sight distance per AASHTO guidelines is provided at all intersections.

h. Intersections:

(1.) The centerlines of no more than two (2) streets shall intersect at any one (1) point. All angles and distances are measure relative to the intersection of the roadway centerlines.

(2.) All intersecting roads should intersect at 90-degree angles. Where this is not possible, an adjustment up to the angles shown in Table 4.1 may be allowed if the right-of-way area located on the acute angle side of the intersection is fully cleared of all trees, brush and other obstructions for a distance of at least twenty-five (25) feet from both intersecting roadways. A right-of-way corner clip shall be further provided on the acute angle side.

(3.) Intersections within a horizontal curve are permitted provided that the intersecting road has a one hundred and fifty (150) feet minimum tangent at the intersection and the required corner sight distance is maintained. Whenever possible, the tangent of the intersecting road is to be radial to the curve but in no case will it be vary from radial more than the intersecting road angles shown in Table 4.1.

i. Curb Radius shall be in accordance with those shown in Table 4.1.

j. Lateral Clearance:

(1.) A minimum lateral clearance as shown below in Table 4.2 shall be maintained from the edge of pavement or from the back of curb or valley of gutter:

Table 4.2 Lateral Clearances

Laydown Curb	6.0’
Barrier Type Curb	4.0’
Ribbon Curb	10.0’
Flat Pavement	10.0’

404. County and State Highways

Provisions shall be made for the extension or widening of county roads and state highways, where required by the Commissioners Court, in order to protect the safety and welfare of the public.

405. Pavement Design

405.01 Flexible Pavement and Pavement Design

Competent design of flexible pavements provides a system that is stable, durable and cost-effective. The primary principle that forms the basis for flexible pavements is that the vehicular loads can be dissipated through successive layers of properly engineered materials. The success of such design is based upon:

1. an evaluation of the subgrade soil;

2. the relative load support value of pavement components; and

3. the magnitude and repetitions of traffic loads.

The minimum pavement values outlined in Tables 4.3 and 4.4 below are pre-approved and provide a user-friendly pavement design method for new roadways based upon the roadway functional classification and the predominant types of soil conditions found in Brazos County. The *1993 AASHTO Guide for Design of Pavement Structures* is the basis for the minimum values in Tables 4.3 and 4.4 below.

> An exception to this minimum pavement standard (Tables 4.3 and 4.4) can be requested for private local roads that provide access to six (6) or fewer lots. Pavement for these privately maintained local roads shall consist of eight-inches (8") of compacted gravel if constructed on non-chemically stabilized subgrade soils. If six-inches (6") of subgrade soil are chemically stabilized, the compacted gravel surface can be reduced to five-inch (5") thickness.

The NRCS Web Soil Survey should be utilized to determine the property USCS Soils Group. This information can be determined for individual site locations and may be found at: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

If an individual pavement design is desired by the developer / engineer rather than use of the values in Tables 4.3 and 4.4 below, the developer shall submit pavement designs prepared by a Licensed Professional Engineer in the State of Texas utilizing the most current *AASHTO Guide for Design of Pavement Structures* and county pavement design coefficients based on soil type, traffic loading and a twenty (20) year minimum design life. Further information for individual pavement designs is provided in Appendix A. All individual designs are subject to County Engineer approval.

Table 4.3 Flexible Pavements – HMAC

FLEXIBLE PAVEMENTS - HMAC					
STREET CLASSIFICATION	USCS GROUP SYMBOL	SUBGRADE TREATMENT [1]	BASE MATERIAL [2]	SURFACE TREATMENT [3]	TOTAL STRUCTURAL NUMBER [4]
LOCAL ROAD	CH	8-in. Sub-Base Layer	7-in. Flexible Base Layer	2-in. HMAC	2.50 (2.50)
	CL	8-in. Sub-Base Layer	6-in. Flexible Base Layer	2-in. HMAC	2.36 (2.21)
	SC	8-in. Sub-Base Layer	6-in. Flexible Base Layer (*)	2-in. HMAC	2.36 (1.86)
MINOR COLLECTOR – RESIDENTIAL	CH	8-in. Sub-Base Layer	12-in. Flexible Base Layer	2.5-in. HMAC	3.42 (3.31)
	CL	8-in. Sub-Base Layer	9-in. Flexible Base Layer	2.5-in. HMAC	3.00 (2.93)
	SC	8-in. Sub-Base Layer	6-in. Flexible Base Layer	2.5-in. HMAC	2.58 (2.48)
MINOR COLLECTOR – COMMERICAL	CH	8-in. Sub-Base Layer	15-in. Flexible Base Layer	3.5-in. HMAC	4.28 (4.18)
	CL	8-in. Sub-Base Layer	11-in. Flexible Base Layer	3.5-in. HMAC	3.72 (3.70)
	SC	8-in. Sub-Base Layer	7-in. Flexible Base Layer	3.5-in. HMAC	3.16 (3.11)
MINOR COLLECTOR – INDUSTRIAL	CH	8-in. Sub-Base Layer	15-in. Flexible Base Layer	3-in. HMAC	4.06 (4.05)
	CL	8-in. Sub-Base Layer	12-in. Flexible Base Layer	3-in. HMAC	3.64 (3.58)
	SC	8-in. Sub-Base Layer	8-in. Flexible Base Layer	3-in. HMAC	3.08 (3.01)
MAJOR COLLECTOR	*Design based upon Geotechnical Report, but not less than pavement structure shown for a Minor Collector.*				
MINOR ARTERIAL	*Design based upon Geotechnical Report, but not less than pavement structure shown for a Minor Collector.*				
MAJOR ARTERIAL	*Design based upon Geotechnical Report, but not less than pavement structure shown for a Minor Collector.*				

Notes:

1	Surface Layer (Hot-Mix Asphalt Concrete – TxDOT Item 340, Type D), Flexible Base Layer (TxDOT Item 247, Type A, Grade 1-2), and Subbase Layer (Lime Stabilized and Compacted Subgrade).
2	The minimum surface layer or HMAC thickness shall not be less than that indicated for each minimum design section.
3	A minimum subbase or chemically stabilized and compacted subgrade layer of 8-inches should be used. Under no circumstance shall the thickness of the subbase layer be reduced. The subbase layer may be increased; however, an 8-inch thick layer should be used to determine the total structural number of the pavement section.
4	Structural layer coefficients used in calculations were 0.44 for HMAC, 0.14 for flexible base, and 0.08 for stabilized subgrade.
5	Summary of other design inputs for residential roadways: S_o = 0.49, R = 70%, P_i = 4.2, and P_i = 2.0.
6	Summary of other design inputs for minor collector roadways: S_o = 0.49, R = 85%, P_i = 4.2, and P_i = 2.25.
7	Summary of other design inputs for commercial roadways and industrial roadways: S_o = 0.49, R = 90%, P_i = 4.2, and P_i = 2.5.
8	(*) Indicates that required minimum flexible base layer thickness is less than 6-inches; however, a minimum base layer of 6-inches is required (see note 3).

Table 4.4 Rigid Pavements

RIGID PAVEMENTS			
STREET CLASSIFICATION	USCS GROUP SYMBOL	SUBGRADE TREATMENT	CONCRETE PAVEMENT
LOCAL ROAD	CH	8-in. Sub-Base Layer	6-in.
	CL	8-in. Sub-Base Layer	6-in.
	SC	8-in. Sub-Base Layer	6-in.
MINOR COLLECTOR – RESIDENTIAL	CH	8-in. Sub-Base Layer	7-in.
	CL	8-in. Sub-Base Layer	7-in.
	SC	8-in. Sub-Base Layer	6-in.
MINOR COLLECTOR – COMMERICAL	CH	8-in. Sub-Base Layer	9-in.
	CL	8-in. Sub-Base Layer	9-in.
	SC	8-in. Sub-Base Layer	8-in.
MINOR COLLECTOR – INDUSTRIAL	CH	8-in. Sub-Base Layer	9-in.
	CL	8-in. Sub-Base Layer	9-in.
	SC	8-in. Sub-Base Layer	8-in.
MAJOR COLLECTOR	*Design based upon Geotechnical Report, but not less than pavement structure shown for a Minor Collector.*		
MINOR ARTERIAL	*Design based upon Geotechnical Report, but not less than pavement structure shown for a Minor Collector.*		
MAJOR ARTERIAL	*Design based upon Geotechnical Report, but not less than pavement structure shown for a Minor Collector.*		

Notes:	
1	Rigid pavement section is assumed to be founded on an 8-inch lime stabilized and compacted subgrade.
2	A minimum rigid pavement section of 6-inches is required for any roadway subjected to truck traffic regardless of computed thickness.
3	Summary of other design inputs for residential roadways: S_o = 0.39, R = 75%, P_i = 4.2, and P_i = 2.0.
4	Summary of other design inputs for minor collector roadways: S_o = 0.39, R = 90%, P_i = 4.2, and P_i = 2.25.
5	Summary of other design inputs for commercial roadways and industrial roadways: S_o = 0.39, R = 90%, P_i = 4.5, P_i = 2.5, J=2.9, and f'c=3,500 psi

405.02 Design Requirements for Pavements on Expansive Soils

Whenever a soil investigation indicates more than two (2) feet of expansive subgrade with PI greater than thirty-eight (>38) exists underneath the expected base layer, the design professional is advised to adopt at least one but preferably a combination of the following measures:

1. Replace eighteen (18) inches of subgrade with approved material with PI less than twenty (<20);

2. If there is no presence of sulfates; use lime, cement, or lime/cement material to stabilize eight (8) to twelve (12) inches of subgrade as appropriate to minimize vertical shrink/swell potential;

3. Reinforcement of the pavement section with Geogrid (placed in the plane between the subgrade layer and the base layer).

    a. A documented Geogrid design must be approved by the County Engineer or designated representative.

b. An acceptable Geogrid design must be used in combination with at least one (1) other strategy listed here.

c. Other measures as may be approved by the County Engineer or designated representative.

405.03 Pavement Structure

1. Subgrade

   a. The preparation of the subgrade shall follow good engineering practices as directed by the County Engineer in conjunction with recommendations outlined in the geotechnical report. When the Plasticity Index (PI) is greater than fifteen (>15), a sufficient amount of lime shall be added as described in Item 260 of the current edition of the TxDOT Standard Specifications for Construction until the PI is less than fifteen (<15). If the addition of lime as described in Item 260 is not feasible, an alternate stabilizing design shall be proposed and submitted to the County Engineer for approval. The subgrade shall be prepared and compacted to achieve a dry density per TxDOT Item 132. In addition, proof rolling may be required by the County Engineer.

   b. The subgrade shall be inspected and approved by an Independent Testing Laboratory and a certified copy of all inspection reports furnished to the County Engineer, who must approve the report prior to application of the base material. All density test reports shall include a copy of the work sheet showing the percentage of the maximum dry (Proctor) density. The number and location of all subgrade tests shall be determined by the County Engineer.

2. Base Material

   a. Base material shall conform to Item 247, Flexible Base, of the current edition of the TxDOT Standard Specifications for Construction. The base material shall be Type A Grade 1 / 2, or as approved by the County Engineer.

   b. Each layer of base course shall be tested for in-place dry density and measured for compacted thickness. The number and location of all base test samples shall be determined by the County Engineer.

   c. The base shall be prepared and compacted to achieve a minimum of 98% of the maximum (Proctor) dry density. The maximum lift shall not exceed six (6) inches. The base must be inspected and approved by an Independent Testing Laboratory and a certified copy of the test results furnished to the County Engineer for approval. Prior to the placement of the first lift of base, the stockpile shall be tested for the specifications found in Item 247 Table 1 of the current edition of the TxDOT Standard Specifications for Construction and the result furnished to the County Engineer for approval.

3. Bituminous Material

    a. Subdivision roads may utilize a wearing surface of HMAC Type D as shown in Table 4.3. The mix shall be from a TxDOT certified plant. The mix design shall be submitted to the County Engineer for approval prior to placement of the material. Contractor's Quality Control (CQC) test reports shall be submitted to the County Engineer on a daily basis. As a minimum, daily CQC testing on the produced mix shall include: Sieve Analysis TEX-200-F, Asphalt Content TEX-210-F, Hveem Stability TEX-208-F, Laboratory Compacted Density TEX-207-F, and Maximum Specific Gravity TEX-227-F. The number and location of all HMAC tests shall be determined by the County Engineer with a minimum of three (3), six inch (6") diameter field cores secured and tested by the contractor from each day's paving. Each HMAC course shall be tested for in-place density, bituminous content and aggregate gradation, and shall be measured for compacted thickness. The number and location of all HMAC test samples shall be determined by the County Engineer.

    b. Rural roads, as defined in the Brazos County Subdivision Regulations, may use a two-course surface in accordance with Item 316, Seal Coat, of the current edition of the TxDOT Standard Specifications for Construction. Pavement Designs for these types of roads are indicated in Appendix A. The type and rate of asphalt and aggregate shall be indicated on the plans as a basis of estimate and shall be determined at the preconstruction conference. Aggregate used in the mix shall be on the TxDOT Quality Monitoring Schedule. Aggregate shall be Type B Grade 3 or Grade 4. Gradation tests shall be required for each three hundred (300) cubic yards of material placed with a minimum of two (2) tests per each grade per each project. Test results shall be reviewed by the County Engineer prior to application of the material.

4. Concrete Pavement

    a. In lieu of bituminous pavement, portland cement concrete pavement may be used. In such cases, the pavement thickness shall be as indicated in Table 4.4, and shall be jointed and reinforced in accordance with the BCS Unified Standard Construction Details and Specifications. The mix shall be from a TxDOT certified plant. The mix design shall be submitted to the County Engineer for approval prior to placement of the material.

5. Concrete – General

    a. Unless otherwise specified, concrete shall be in accordance with Item 421, Hydraulic Cement Concrete and Item 360, Concrete Pavement, of the current edition of the TxDOT Standard Specifications for Construction and be placed in accordance with the applicable item.

    b. All reinforcement shall meet Item 360, Concrete Pavement, of the current edition of the TxDOT Standard Specifications for Construction.

c. All concrete shall be tested for compressive strength. One (1) set of three (3) concrete test cylinders shall be molded for every fifty (50) cubic yards of concrete placed for each class of concrete per day, or at any other interval as determined by the County Engineer. A slump test shall be required with each set of test cylinders. One (1) cylinder shall be tested for compressive strength at an age of seven (7) days and the remaining two (2) cylinders shall be tested at twenty-eight (28) days of age.

406. Major Structures and Bridges

Design of structures shall be designed by a Licensed Structural Engineer in the State of Texas. All structures shall be designed per TxDOT standards and shall conform to the TxDOT's Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, latest edition. Bridge design loading and widths for roads shall conform to TxDOT design, or as directed by the County. Structures of this nature require the specific approval of the County.

407. Road Names and Road Signs

407.01 Road Names and Road Signs

1. Road names for new subdivision roads should be suggested by the Applicant and shall conform to the County's adopted standards. Suggested road names will be reviewed and reserved by the 9-1-1 Address Administrator for inclusion on final plat submissions. Road names are approved along with plat approval by the Commissioners Court.

2. The Applicant shall install all road name signs on new roads when they are constructed in accordance with the standards and specifications of the County.

3. The Applicant shall be required to install any traffic control signs or devices, in accordance with the Texas Manual on Uniform Traffic Control Devices, and following review by the County Engineer and/or County Commissioner.

4. Aluminum Sign Blanks: All sign blanks must meet or exceed TxDOT Departmental Materials Specification DMS-7110. Minimum Thickness for Signs less than seven and a half (<7.5) square feet shall be 0.08-inches. Minimum Thickness for Signs greater than seven and a half (>7.5) square feet shall be 0.10-inches.

5. Plywood Sign Blanks will not be accepted.

6. Unless otherwise specified when order is placed, all sign items (except for Street Name Signs) shall meet or exceed requirements of Type III Prismatic Retroreflective Sheeting as per the Texas Manual on Uniform Control Devices, latest edition, for the items designated. Type III (or greater) Sign Face Materials must meet Sheeting and Material Requirements in TxDOT Departmental Material Specifications DMS-8300.

408. Roadway Access Management

408.01 Roadway Access Management

1. Proper access management assists in protecting the substantial public investment in transportation by preserving roadway efficiency and enhancing traffic safety, thus reducing the need for expensive improvements. Furthermore, access management can significantly reduce traffic accidents, personal injury, and property damage. To appreciate how access management fits into the entire spectrum of the roadway network, one should understand that freeways, arterials, collectors, and local streets serve varying levels of through-traffic movement and access to property.

    a. Arterials: Provide the next highest level of mobility and are intended to carry substantial amounts of traffic over relatively long distances and at relatively high speeds. Direct property access may be provided but must be carefully managed to preserve arterial mobility and avoid creating unsafe and congested traffic operations.

    b. Collectors: Provide lower mobility and are intended to carry lower volumes of traffic at lower speeds. Since most of the trips on collectors are shorter distance local trips, these streets can safely provide a higher amount of property access.

    c. Local Streets: Provide the lowest level of mobility and are intended to provide direct access to properties, preserve the neighborhood environment, and enhance pedestrian and bicycle safety.

2. The access connection distances shown below are based upon stopping sight distance and are intended for passenger cars on a level grade. These distances may be increased for downgrades, truck traffic, or where otherwise indicated for the specific circumstances of the site and the roadway. In other cases, shorter distances may be appropriate to provide reasonable access, and such decisions should be based on safety and operational factors supported by an engineering study. The distance between access connections is measured along the edge of the traveled way from the closest edge of pavement of the first access connection to the closest edge of pavement of the second access connection.

Table 4.5 Driveway Connection Spacing Criteria

Driveway Connection Spacing Criteria (1) (2) (3)	
Posted Speed (mph)	Distance (ft)
≤ 30	200
35	250
40	305
45	360
≥ 50	425

(1) Distances are for passenger cars on level grade. These distances may be adjusted for downgrades and/or significant truck traffic. Where present or projected traffic operations indicate specific needs, consideration may be given to intersection sight distance and operational gap acceptance measurement adjustments.
(2) When these values are not attainable, refer to the variance process as described below.
(3) Access connection spacing below the values shown in this table may be approved based on safety and operational considerations as determined by County Engineer.

409. Guardrails and Guardrail Terminals

409.01. Guardrails

A guardrail is, first and foremost, a safety barrier intended to protect a motorist who has left the roadway. The best-case scenario, if a car leaves the roadway, would be for that car to come to rest unhindered. In some cases and places, however, that is not possible. The roadway may be abutted by steep embankments or side slopes, or it may be lined with trees, bridge piers, retaining walls, or utility poles. Sometimes it is not feasible to remove those things.

In those cases – when the consequences of striking a guardrail would be less severe than striking the other objects next to the roadway – guardrails should be installed. They can make roads safer and lessen the severity of crashes. The guardrail can operate to deflect a vehicle back to the roadway, slow the vehicle down to a complete stop, or, in certain circumstances, slow the vehicle down and then let it proceed past the guardrail.

Guardrails cannot completely protect against the countless situations drivers may find themselves in. The size and speed of the vehicle can affect guardrail performance. So can the vehicle's orientation when it strikes the guardrail as well as many other factors.

When guardrail usage is necessary, the design of guardrails shall be in accordance with the TxDOT Roadside Design Manual Appendix A – Longitudinal Barriers Sections 1-4 and Sections 6-7.

New installations shall be approved by the County Engineer. They should be MASH compliant and installed in accordance with latest TxDOT standards.

A partial list of MASH compliant systems can be found at:
https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/listing.cfm?code=long&filter=MASH

409.02. Guardrail Terminals

Similar to guardrails, guardrail terminal design and installations are important to motorist safety.

New installations shall be approved by the County Engineer. They should be MASH compliant and installed in accordance with latest TxDOT standards.

A partial list of MASH compliant systems can be found at:
https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/listing.cfm?code=long&filter=MASH

Guidance from FHWA and a list of TxDOT standards can be found at:

https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/policy_memo_guidance.cfm

http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/rdwylse.htm#GUARDRAILENDTREATMENTS

410. Construction Requirements.

410.01 Within the County Easements/Right-Of-Way's.

A preconstruction meeting shall be scheduled prior to the start of construction. The Design Engineer, Owner, Contractor, Subcontractors, and County Engineer shall attend this meeting.

410.02 Within the County Easements/Right-Of-Way's.

1. Structural Zones: Any area that will or may receive and additional loading of weight or energy. To include all roads, road easements, detention or retention ponds.

2. Non-Structural Zones: Vegetated storm ditch or other area in right-of-way that will not receive additional loading of weight or energy.

410.03 Inspections.

1. All elements of roadway and storm drain system construction, in both Structural and Non-Structural Zones must be inspected and approved by the County Engineer's Office as a prerequisite for acceptance by Brazos County. This will include, but is not limited to:

    a. Subgrade Surface after clearing and grubbing;

    b. Storm Drain System and all related structures;

    c. Detention/Retention Ponds;

d. Embankments;

e. Utilities relocated within the structural zone;

f. Subgrade for roads;

g. Base Course;

h. Asphalt Paving;

i. Finished grade of road right-of-way; and

j. Permanent Vegetation Establishment.

2. It is the contractor's responsibility to insure the County Engineer's office is notified upon completion of each phase of construction and has the opportunity to make their inspections before proceeding to the next phase. It should be understood that the inspections conducted by the County Engineer's office are for the protection of Brazos County only. They are not intended to certify the contractor's satisfactory discharge of his obligation to the owner, nor do they relieve the project engineer from any of his responsibilities with regard to inspection and contract administration.

410.04 General Instructions to Contractors.

The following procedures for implementation of the County's inspections and final approval shall be followed. It is recommended that these instructions be included in the contract documents for the construction contract.

1. Applicability: As a prerequisite to County approval and acceptance of new streets, all phases of construction must be inspected and approved by the County Engineer's office. This applies to all subdivision streets constructed under the jurisdiction of Brazos County Subdivision Regulations whether they are to be dedicated to Brazos County or not.

2. Specifications: All construction and materials shall comply with the latest edition of the TxDOT Standard Specifications for Highway Construction unless specifically noted otherwise herein. These requirements and TxDOT specifications shall supersede the engineer's specifications in the event of a discrepancy.

3. Testing: The contractor is responsible for providing all geotechnical and materials testing and the accompanying documentation at no cost to the County.

    a. All materials shall be sampled and tested by an Independent Testing Laboratory in accordance with the construction documents approved by the County Engineer. The Owner shall pay for all testing services and shall furnish the County Engineer with certified copies of these test results. All testing is to be identified on forms as to the exact location (Street name, Sta. No.'s, and elevation in regards to finished grade.);

b. The County Engineer must approve the test results prior to constructing the next course of the roadway pavement structure. Unless otherwise stated herein, the proctor densities required under these procedures are standard proctor densities.

c. Any material which does not meet the minimum required test specifications shall be removed and recompacted or replaced unless alternative remedial action is approved in writing from the County Engineer.

4. Notifications: After receiving approval of street, storm drainage and sediment and erosion control plans, the contractor or engineer must contact the County Engineer's office with a start date for construction at least forty-eight (48) hours in advance. Upon completion of site clearing and grubbing and erosion control installation a mandatory site meeting may be held. Meeting is to be arranged by the contractor or project engineer. Meeting shall be attended by project engineer, contractor, developer, geotechnical engineer, county engineer, and any utilities that will or may encroach on/into a right-of-way. (Attendee must be a responsible representative; meeting should be timely planned and the county notified at least forty-eight (48) hours in advance.)

5. Erosion Control: Before starting any grading work, install sediment and erosion control measures per the approved plans to protect any downstream water bodies. The contractor is responsible for implementation and weekly or bi-weekly monitoring of the sediment and erosion control plan in accordance with TCEQ Regulations, insuring inspection logs are available on site at all times, and for insuring that silt and sediment do not leave the site.

6. Inspections: Requests for any inspection must be arranged with the County Engineer's office twenty-four (24) hours in advance.

7. Other Regulations: The developer and contractor are also responsible for compliance with all applicable regulations administered by other agencies, such as:

   a. TCEQ.

   b. U.S. Army Corps of Engineers.

   c. TxDOT.

   d. Municipalities.

   The County Engineer's office may withhold approval at any stage of construction, including final approval, for failure to comply with these regulations.

410.05 Required Geotechnical Testing and County Inspections

1. Mandatory Initial Subgrade Surface Inspection: After clearing and rough grading of streets but prior to placement of any storm drain or fill for road way embankments, a mandatory subgrade surface inspection is required.

   The developer, contractor, project engineer, geotechnical engineer, any utilities that may be working within a structural zone and the County Engineer's office should be present. This inspection shall be set up by the contractor or the project engineer.

   A rubber tire backhoe or motor grader is needed for this inspection in order to confirm that all stumps, roots and unacceptable soils have been removed. A proof-roll may be conducted during this inspection at the discretion of the County Engineers' office or geotechnical engineer. All deficiencies identified during this inspection must be corrected by the contractor before the next inspection is requested. The consulting engineer or geotechnical engineer as well as the County Engineer's office and contractor should be represented. This inspection shall be set up by the contractor or the consulting engineer.

2. Except for electrical lines, all underground nonferrous utilities within a right-of-way or easement must be accompanied by ferrous metal lines to aid in tracing the location of said utilities through the use of a metal detector.

3. Detention/Retention Ponds: Such areas to be considered Structural Zones. Pond dikes are to be constructed with fill approved by and signed off on by the geotechnical engineer; absolutely No Organics are permitted in dikes. Fill material is to be tested every foot (1-FT) in elevation and every one hundred (100) linear feet, with a minimum of two (2) tests per lift. Trenches through a pond dike are to be considered a Structural Zone and should be tested accordingly. All fill must be compacted to at least ninety-five percent (95%) of maximum proctor density. County Engineer is to be copied on all testing.

4. Trenching and Backfilling: Storm drain or utility trench bedding and backfill must be a county approved material, be visually inspected, and signed off on by the geotechnical inspector and a copy of the inspection must be sent the Brazos County.

   The contractor shall notify the County Engineer's office when backfilling of storm drainage or utility excavations within a Structural Zone is to take place. Backfill in these excavations shall be cement stabilized sand meeting BCS Unified Specifications.

   County Engineer is to be copied on all testing. If not properly notified, or if the test results are unsatisfactory, the County Engineer's office may require excavation and re-compaction of the backfill. No proof-roll of the subgrade will be scheduled until the cement stabilized backfill compaction and strength has been documented.

5. Erosion Control: Install sediment and erosion control measures around storm drain inlets as they are constructed. Sediment basins and detention ponds must be in place(s) at this time. All erosion control shall be in accordance with the approved Erosion Control Plan.

6. Storm Drain Boxes: All Boxes whether inside a Structural Zone or a Non-Structural Zone, must be backfilled with cement stabilized sand meeting the most current edition of the BCS Unified Specifications.

7. Embankments: All stumps and large roots must be removed from the roadbed prior to placement to fill for embankments regardless of fill height. All roadway embankment and embankment fill must be approved by and signed off on by the geotechnical engineer. Roadway embankment fill to placed and compacted in lifts not exceeding eight inches (8”). The contractor is responsible for providing geotechnical testing and documentation that the embankment material has been compacted to ninety-five percent (95%) of maximum proctor density. Density testing of embankment fills to be performed every foot (1-FT) of fill every two hundred and fifty (250) feet alternating lanes with a minimum of two (2) tests per road, per foot (1 FT) of fill. County Engineer’s office is to be copied on all testing. No proof-roll of the subgrade will be scheduled until the compaction has been documented.

8. Embankment Modifications: Any roadway embankment modifications (extra stone, soil, cement, lime treatment, geo grid, etc.) must be approved by the geotechnical engineer and the County Engineer notified of such modifications.

9. Curb and Gutter Proof-Roll: Curb and gutter must be placed on compacted and approved subgrade or base material. Prior to scheduling a curb and gutter proof-roll the County Engineer’s office must be in receipt of all density testing data required to be completed at this stage of construction. The geotechnical inspector, contractor, project engineer and County Engineer shall be present for the proof-roll.

   NOTE: Upon completion of a passing curb and gutter proof-roll, absolutely no excavation or trenching is to be done in a Structural Zone (Roadway or Roadway Easement) without the approval of the Brazos County Engineer’s office.

10. Subgrade Proof-Roll: Prior to scheduling a subgrade proof-roll, the County Engineer’s office must be in receipt of all density testing data (subgrade should have been tested every two hundred and fifty (250) feet, alternating lanes testing to be completed on cut or fill), required to be completed at this stage of construction. It is the responsibility of the contractor to provide independent density verification prior to proof-rolling and at no cost to Brazos County. After fine grading of subgrade, but prior to placing base material, the subgrade must be proof-rolled with a loaded tandem axle dump truck or pan. The contractor shall schedule this inspection. The geotechnical engineer, County Engineer’s office and contractor shall be represented. The County Engineer’s office reserves the right to conduct or require additional testing at any time. The minimum acceptable subgrade density is ninety-five percent (95%) of maximum proctor density.

No base course material or curbs should be placed prior to written approval of the subgrade from the County Engineer's office.

NOTE: Any completed and approved subgrade left exposed for over two (2) weeks or damaged by inclement weather must be re-inspected and approved by the County Engineer's office. This may include another proof-roll if necessary in the judgment of the County Engineer's office.

Any excavation within a tested and county approved subgrade shall be treated as new excavation and complete density testing and proof-rolling requirements must be met.

11. Catch Basins: The location and orientation of the catch basins relative to the curb and gutter, as well as the roadway width, should be confirmed at this time. Catch basins improperly placed must be relocated and/or reconstructed. All catch basins must have a temporary drain by which standing water can be drained from the surface of the subgrade and base during construction. These drains must be properly plugged before the final inspection is required.

12. Base Course: Placement of base course material is only permitted on a County approved subgrade. Flexible Base course material meeting TxDOT Item 247 Specifications or other alternatives as approved by the County Engineer's office (cement stabilized, geo grid, etc.). All base course materials are to be density tested every three hundred (300) feet in alternating lanes with a minimum of two (2) tests on any road no matter the length. Thickness of base of course material must be verified at each density test location. It is the responsibility of the contactor to provide independent density verification at no cost to Brazos County.

13. Graded Aggregate Base Course: If base course is thicker than eight-inches (8") it shall be placed and compacted in equal lifts. If base course is less than twelve–inches (<12") it can be tested (not placed) as one (1) lift. If base course is twelve-inches or greater (≥12") it must be placed, compacted and density tested in equal lifts. Example: thickness is twelve-inches (12"), place, compact and test at six-inches (6") and place, compact and test at twelve-inches (12").

14. Base Course Proof-roll: Prior to scheduling a Base Court Proof-Roll the County must be in receipt of all base course density testing and thickness verification reports. If the average base course thickness is found to be deficient by more than one-half inch (½") or any individual measurement deficient by more than one inch(>1"), the deficiency will be corrected by scarifying, adding base material, re-compacting and density testing. Upon completion of the curbing and base course, the contractor shall schedule an inspection to proof-roll the base with a loaded tandem axle dump truck. The geotechnical engineer, County Engineer and contractor shall be represented. The contractor will provide proctor and gradation information on the base material from an independent testing firm as well as verification that all applicable compaction and depth requirements have been satisfied.

NOTE: Any completed and approved stone base left exposed for over one week or damage by inclement weather must be re-inspected and approved by the County Engineer's office. This may include another proof-roll if necessary in the judgment of the County Engineer's office.

15. Asphalt Prime: Asphalt Prime meeting TxDOT Item 300 (generally MC-30 or A-EP) must be placed at rate specified in plans. Prime shall be allowed to cure for five (5) to seven (7) days prior to placement of Hot Mix Surface.

16. Proof-Roll of Roadway Right-of-Way: Right-of-Way should be properly graded and compacted according to plans. All water is to drain away from the roadway. In lieu of density testing in Roadway Easement, a proof-roll will be conducted by the County Engineer's office. Proof-Roll is to be scheduled by the contractor prior to grassing. A rubber tire backhoe pickup truck, rubber tire skid loader is preferred for this proof-roll. A maximum of one-inch (1") deflection is permitted during this proof-roll.

410.06 Paving

1. Asphalt Requirements: Unless another type has been approved in advance, by the County Engineer's office for a specific project, hot mix asphalt pavements shall meet: TxDOT Item 340, Dense-Graded Hot-Mix Asphalt.

2. Coordination: After approval of asphalt prime application to the base course, there must be coordination between the paving contractor and the County Engineer's office with regard to the schedule for paving. If possible, a County inspector will be present during paving operations but it is not mandatory unless so designated by the County Engineer.

    a. Asphalt is only to be placed on a county approved base.

    b. If more than one (1) week passed or there is one-quarter-inch (1/4") or more rain prior to paving and approved base, the base must be re-inspected by the County visually, and possibly proof-rolled.

    c. Minimum asphalt thickness for initial/ first lift is two-inches (2"). If pavement thickness is greater than 2.5" it shall be placed in two stages.

    d. Placement of hot mix asphalt will not be authorized when surface temperatures are less than forty-five degrees Fahrenheit (45°F).

    e. Brazos County Engineer's office to visually inspect pavement and review Asphalt core test data at all phases of paving, binding, intermediate and surface course.

    f. Asphalt tack coat to be placed between all courses no exceptions.

3. Final Surface Course: An existing asphalt concrete binder or vase course must be inspected and approved prior to placement of the asphalt surface course. Verification of in-place density and thickness of the binder or base course must be provided as a prerequisite to this approval. Failure to obtain this approval will make the street ineligible for final approval and acceptance by the County.

4. Asphalt Requirements: Asphalt verification testing will be conducted in accordance with TxDOT Standard Specifications for Highway Construction, 2014 Edition. The contractor shall be responsible for providing verification for the asphalt type, asphalt binder content, gradation and the average laboratory bulk specific gravity (BSG) for all asphalt mixes used on Brazos County projects as well as the in-place asphalt density and thickness. The asphalt contractor must have an asphalt laboratory certified by the TxDOT for state highway projects.

   For each day's production, the contractor's asphalt lab must provide:

   a. Average laboratory BSG

   b. Asphalt binder content

   c. Gradation

   d. Mix type

   The in-place density and thickness determination of asphalt surface and binder courses will be based on the core data for day's production. Cores will be obtained every five hundred feet (500-FT) in alternating lanes with a minimum of one (1) core on any road no matter the length, immediately after completion and the holes patched with hot asphalt from the same day's production. The cores will be taken and evaluated by either the asphalt contractor or an independent materials testing firm certified by TxDOT for state highway projects.

   The pavement will be rejected, removed and replaced if the average in-place core density does not meet the requirements of TxDOT Item 340, Dense-Graded Hot-Mix Asphalt.

   The average pavement thickness must be equal to or greater than the plan thickness with no individual core varying by more than 0.25". Pavements that are deficient with regard to thickness will either be removed and replaced or overlaid at the discretion of the County Engineer. Each core will be tested for the presence of hydrated lime in the mix.

   Documentation of the asphalt verification testing must be provided prior to requesting a final inspection. The Brazos County Engineer's office reserves the right to conduct or require additional verification testing at any time.

410.07 Final Approval

1. Final Inspection: Final Inspection may be requested once all the paving and all utility, storm drainage and associated work is completed as well as the following items:

   a. Permanent grass on road shoulders; cut and fill slopes and easements; ditches;

   b. Fence around detention ponds;

   c. Street name signs (County Standard or an approved alternate);

   d. Traffic control signs (per Texas MUTCD); and

   e. As-built Drawings.

2. Documentation: As a prerequisite to conducting the final inspection, the following must be provided:

   a. Digital submission of as-built plans;

   b. 11" x 17" hard copy of as-built plans;

   c. Right of way deeds for roads and drainage system;

   d. Two (2) year maintenance bond for road and drainage systems; and

   e. Documentation of construction materials testing.

3. Punch List: A written punch list of deficiencies found during the final inspection will be provided. All items should be completed before requesting a re-inspection.

4. Final Approval: Upon satisfactory completion of all punch list items, a construction approval letter of the streets and drainage system will be issued by the County Engineer. Construction approval does not convey intent of Brazos County to provide maintenance acceptance. Construction approval initiates the two (2) year warranty period as described in Brazos County Subdivision Regulations Article 10.

   NOTE: Failure to comply with any of the above listed requirements could render the streets and storm drainage systems ineligible for acceptance by Brazos County.

ARTICLE 5. HYDROLOGY

501. Introduction Analysis Methods

The two types of hydrologic analyses most often required are the computation of the peak discharge at a specific location and the computation of a hydrograph at a specific location. Two methods are recommended for computation of peak discharges and two methods are recommended for computation of hydrographs. The application of these methods is a function of the purpose of the hydrologic examination and the size of the Design Drainage Areas being examined as outlined in these Guidelines. In special circumstances, other computational methods of proven use may be submitted to the County Engineer for approval. It is highly recommended that approval be obtained before significant hydrologic work is accomplished for a project.

502. Stormwater Runoff Calculation Methods

502.01. The Rational Formula

The Rational Method is appropriate for estimating peak discharges for small drainage areas. In the case with Rural Subdivisions, as defined in the Brazos County Subdivision Regulations, and rural areas of the County, the Rational Method may be used for areas of up to about 200 acres with no significant flood storage. In the case with Urban Subdivisions, as defined in the Brazos County Subdivision Regulations, and urban areas of the County, the Rational Method may be used for areas of up to 50 acres with no significant flood storage.

1. Assumptions and Limitations:

   Use of the rational method includes the following assumptions and limitations:

   a. The method is applicable if "t_c" for the drainage area is less than the duration of peak rainfall intensity.

   b. The calculated runoff is directly proportional to the rainfall intensity.

   c. Rainfall intensity is uniform throughout the duration of the storm.

   d. The frequency of occurrence for the peak discharge is the same as the frequency of the rainfall producing that event.

   e. Rainfall is distributed uniformly over the drainage area.

   f. The minimum duration to be used for computation of rainfall intensity is ten (10) minutes. If the time of concentration computed for the drainage area is less than ten (10) minutes, then ten (10) minutes should be adopted for rainfall intensity computations.

g. The rational method does not account for storage in the drainage area. Available storage is assumed to be filled.

h. The Rational Formula shall only be used to estimate peak discharges at specific designated design points

i. The contributing area "A" of runoff shall not exceed 200 acres in rural areas with no significant flood storage and 50 acres in urban areas with no significant flood storage.

If any one of these conditions is not true for the watershed of interest, the designer should use an alternative method.

The rational method represents a steady inflow-outflow condition of the watershed during the peak intensity of the design storm. Any storage features having sufficient volume that they do not completely fill and reach a steady inflow-outflow condition during the duration of the design storm cannot be properly represented with the Rational Method. Such features include detention ponds, channels with significant volume, and floodplain storage. When these features are present, an alternate rainfall-runoff method is required that accounts for the time-varying nature of the design storm and/or filling/emptying of floodplain storage. In these cases, the hydrograph method is recommended.

2. Variables:

The Rational Method formula shall be expressed as:

$$Q = ciA$$

Equation 5-1

Where the variables are defined below.

- **"Q"** is the discharge in exact units of acre-inches per hour and accepted to be equivalent to units of cubic feet per second (cfs). This value is taken as the peak or highest discharge expected at a designated design point.

- **"c"** is a coefficient, having no units, that represents the average runoff characteristics of the land cover within the drainage area delineated for a designated design point.

- **"i"** is the rainfall intensity in units of inches per hour (in/hr.).

- **"A"** is the area of land in acres that contributes stormwater runoff that passes through or at a designated design point.

a. Intensity-Duration-Frequency Relationship:

Rainfall intensity (i) is defined as the average rate of rainfall in inches per hour. It can be determined for storms of various return frequencies as commonly represented by several

intensity-duration-frequency (IDF) curves in graphical form. Duration ranges from ten minutes to 24 hours and is assumed to be the time of concentration. Rainfall intensities may be determined from (IDF) curves or from the equations presented below.

Table 5.1. Equations for Calculating Rainfall Intensities

Storm Frequency	Intensity (i) (inches per hour)
2-Year	$56.19 / (t_c + 10.46)^{0.8147}$
5-Year	$70.86 / (t_c + 10.80)^{0.8012}$
10-Year	$85.71 / (t_c + 11.21)^{0.8028}$
25-Year	$106.03 / (t_c + 11.90)^{0.8028}$
50-Year	$128.46 / (t_c + 12.92)^{0.8067}$
100-Year	$143.06 / (t_c + 12.83)^{0.798}$

Source: TxDOT Hydraulic Manual, 2016.

These equations approximate the IDF curves within a reasonable margin of error. For the Rational Method, the critical rainfall intensity is that having a duration equal to the time of concentration of the design drainage area. Determination of time of concentration (t_c) is discussed in 502.01.2.c. below.

b. Runoff Coefficients

(1.) Urban Watersheds

For Urban Watersheds the BCS Unified Design Guidelines shall be utilized to select the appropriate runoff coefficient "c".

(2.) Rural & Mixed-Use Watersheds

Table 5.2 shows an alternate, systematic approach for developing the runoff coefficient. This table applies to rural watersheds only, addressing the watershed as a series of aspects. For each of four aspects, the designer makes a systematic assignment of a runoff coefficient "component." Using Equation 5-2, the four assigned components are added to form an overall runoff coefficient for the specific watershed segment.

The runoff coefficient for rural watersheds is given by:

$$C = C_r + C_i + C_v + C_s$$

Equation 5-2

Where:

C = runoff coefficient for rural watershed
C_r = component of coefficient accounting for watershed relief
C_i = component of coefficient accounting for soil infiltration
C_v = component of coefficient accounting for vegetal cover
C_s = component of coefficient accounting for surface type

The designer selects the most appropriate values for C_r, C_i, C_v, and C_s from Table 5.2.

Table 5.2: Runoff Coefficients for Rural Watersheds

Watershed Characteristic	Extreme	High	Normal	Low
Relief - C_r	0.28-0.35 Steep, rugged ter-rain with average slopes above 30%	0.20-0.28 Hilly, with average slopes of 10-30%	0.14-0.20 Rolling, with aver-age slopes of 5-10%	0.08-0.14 Relatively flat land, with average slopes of 0-5%
Soil infiltration - C_i	0.12-0.16 No effective soil cover; either rock or thin soil mantle of negligible infil-tration capacity	0.08-0.12 Slow to take up water, clay or shal-low loam soils of low infiltration capacity or poorly drained	0.06-0.08 Normal; well drained light or medium textured soils, sandy loams	0.04-0.06 Deep sand or other soil that takes up water readily; very light, well-drained soils
Vegetal cover - C_v	0.12-0.16 No effective plant cover, bare or very sparse cover	0.08-0.12 Poor to fair; clean cultivation, crops or poor natural cover, less than 20% of drainage area has good cover	0.06-0.08 Fair to good; about 50% of area in good grassland or wood-land, not more than 50% of area in cul-tivated crops	0.04-0.06 Good to excellent; about 90% of drain-age area in good grassland, wood-land, or equivalent cover
Surface Storage - C_s	0.10-0.12 Negligible; surface depressions few and shallow, drain-ageways steep and small, no marshes	0.08-0.10 Well-defined sys-tem of small drainageways, no ponds or marshes	0.06-0.08 Normal; consider-able surface depression, e.g., storage lakes and ponds and marshes	0.04-0.06 Much surface stor-age, drainage system not sharply defined; large floodplain stor-age, large number of ponds or marshes
Table 5.2 Note: The total runoff coefficient based on the 4 runoff components is $C = C_r + C_i + C_v + C_s$				

While this approach was developed for application to rural watersheds, it can be used as a check against mixed-use runoff coefficients computed using other methods. In so doing, the designer would use judgment, primarily in specifying C_s, to account for partially developed conditions within the watershed.

(3.) Mixed Land Use

For areas with a mixture of land uses, a composite runoff coefficient should be used. The composite runoff coefficient is weighted based on the area of each respective land use and can be calculated as:

$$C_w = \frac{\sum_{j=1}^{n} C_j A_j}{\sum_{j=1}^{n} A_j}$$

Equation 5-3

Where:

C_W = weighted runoff coefficient
C_j = runoff coefficient for area *j*
A_j = area for land cover *j* (ft^2)
n = number of distinct land uses

c. Time of Concentration

(1.) Principles --Time of Concentration (t_c) is the theoretical time required for a drop of rain to travel from the most hydraulically remote point in a Design Drainage Area to a point where storm flow is to be determined (the point of calculation). Assuming rainfall is uniform over time and uniform on the watershed, the time of concentration is the first moment when the entire Design Drainage Area is contributing to the runoff at the point of calculation, because during that time all other parts of the Design Drainage Area will also be contributing flow to that point. This is fundamental to estimating total flow at the point of calculation based on the assumption of uniform rainfall over time, as accomplished using the Rational Method.

(a.) Hydrograph Peak

When used within computations using shaped unit hydrographs, the time of concentration is used (usually indirectly) to determine the timing of the peak of the hydrograph in relation to the beginning of the storm event.

(b.) Watershed Peak

The length of time will depend on several characteristics of the Design Drainage Area. Slope, ground cover, degree of concentration, and the antecedent moisture content of the soil are principle among these. When such characteristics are not entirely uniform it is necessary to assess the composite effects of differing characteristics found in parts of the Design Drainage Area. Because hydraulic equations are rarely linear in nature, the averaging of characteristics, such as slope, can readily create inaccuracies. Likewise, multiple variations in characteristics of the Design Drainage Area can cause compounding of inaccuracies, thus generating unreliable results.

(c.) Segment Analyses

In order to ensure accurate results, each segment having different characteristics must be calculated independently, and the resulting times then added to obtain the overall time of concentration (t_c). The time of concentration should be determined

for each segment of significantly differing slope, surface roughness, and/or cross-sectional area. Values of velocity (v) for determining (t_c) for each segment are given in Table C-1 in Appendix C. The time needed for runoff to flow through each of these segments is known as Travel Time (T_t).

(d.) Flow Characteristics

To expedite these calculations, formulas have been developed to estimate travel time by factoring out certain variables from the basic hydraulic equations. Some are assumed to be effective for the initial sheet flow state where the runoff is spread very thinly over a relatively wide area. Some equations are applied to a condition known as 'shallow concentrated flow' in which the runoff is not in a uniform sheet, but is concentrated in an irregular manner not allowing determination of flow cross sections. Where flow is channelized in a reasonably uniform manner allowing use of cross section information, Manning's Equation is normally used to determine velocity, and thus time of travel.

(2.) Analysis *Criteria* -- For purposes of consistency, these Guidelines provide a single set of equations for the estimation of Time of Concentration. These equations and related criteria are adapted directly from the TR-55 manual published in 1986 by the Soils Conservation Service (now the Natural Resources Conservation Service). In special conditions, other accepted methods may be submitted to the County Engineer for consideration as special designs.

(a.) *Initial Sheet Flow:* For initial flow areas, which are both uniform and planar, Manning's Kinematic equation (shown below as published by Overton and Meadows, 1976) should be used. Its use is based on the four assumptions listed below. In no case should a length exceeding 300 feet be considered.

- Shallow uniform steady flow
- Constant rainfall intensity
- Rain duration of 24 hours
- Infiltration does not impact travel time

$$T_t = \frac{0.0007(nL)^{0.8}}{(P_i)^{0.5} S^{0.4}}$$

Equation 5-4

Where:

T_t = Travel time (hours)
n = Mannings' roughness coefficient for sheet flow (refer to Table C-2, Appendix C and TxDOT Hydraulic Design Manual for Manning's Values).
L = Overland flow distance (feet)
P_i = Recurrence interval for the 24-hour rainfall depth (inches) in the ith year (Table C-3, Appendix C)
S = Slope of land (feet per foot)

(b.) *Shallow_Concentrated Flow:* For reaches where the flow is no longer uniform and planar, and a flow cross section cannot be determined, the equation for shallow concentrated flow should be used. This equation estimates flow velocity, which can be translated into travel time.

$$T = \frac{D}{60V}$$

Equation 5-5

Where:

T = Travel time (minutes)
D = Flow distance (feet), and
V = Average velocity of runoff (feet per second)

(c.) *Channel Flow:* Where a flow cross section can be determined, Manning's Equation should be used with appropriate factors for the segment being analyzed. The time of concentration shall not be taken as being less than 10 minutes.

502.02 Natural Resource Conservation Service (formerly SCS) Methods

1. Hydrology Principles

   a. The Hydrology principles, variables, and assumptions used for the NRCS Method shall be computed per the NRCS Methods Section of the BCS Stormwater Design Guidelines.

502.03 Hydrograph Methodology

1. Hydrographs

   a. Two methods of determining a hydrograph are accepted for use. These are the Tabular Method of NRCS (formerly SCS) Technical Release No. 55, and the NRCS (formerly SCS) Dimensionless Unit Hydrograph method. These principles, variables, and assumptions for these computations shall be per the BCS Stormwater Design Guidelines.

502.04 Applications

1. The Rational Method

   a. The Rational Formula shall be limited to use in determining the peak discharge from small areas of overland or sheet flow, and concentrated flows in street gutters, storm sewer, and man-made channels. In the case with Rural Subdivisions, as defined in the Brazos County Subdivision Regulations, and rural areas of the County, the Rational Method may be used for areas of up to about 200 acres with no significant flood storage. In the case with Urban Subdivisions, as defined in the Brazos County Subdivision Regulations, and urban areas of the County, the Rational Method may be used for areas of up to 50 acres with no significant flood storage. It shall not be used for determining or estimating storage or discharge requirements for design of detention facilities. Likewise it shall not be used to estimate stormwater discharges of the primary system. Its use is strictly limited to small drainage areas discharging to the secondary drainage system.

2. Natural Resource Conservation Service (NRCS) Methods

    a. Technical Release No. 55 Methods are for use in determining stormwater discharges and hydrographs in the Secondary Drainage System only and for drainage areas not exceeding 2000 acres. For purposes of these Guidelines these methods are applicable to drainage areas of 50 to 2000 acres. In the event a drainage area exceeding 2000 acres is to be analyzed, it must receive approval of the County Engineer.

3. Dimensionless Unit Hydrograph Method

    a. Where analyzing a primary drainage system, this method must be used.

4. Detention Facilities

    a. All stormwater detention facilities must be designed utilizing the hydrograph methodology, Tabular Method of NRCS TR55 or the NRCS Dimensionless Unit Hydrograph as outlined in the BCS Stormwater Design Guidelines.

ARTICLE 6. HYDRAULICS

601. Hydraulics

601.01 General

1. This section covers the design and construction of drainage systems associated with street drainage, storm sewer systems, open channels, detention facilities, culverts and bridges.

601.02 Street Drainage/Storm Drain Inlets/Storm Drainage Systems/Open Channels

1. All street drainage, storm drain inlets, storm drainage systems and open channels shall be designed in accordance with the BCS Stormwater Design Guidelines, except as modified herein. For Urban Subdivisions, as defined in the Brazos County Subdivision Regulations, all street drainage facilities shall meet the BCS Stormwater Design Guidelines. For Rural Subdivision, as defined in the Brazos County Subdivision Regulations, all street drainage facilities shall meet the BCS Stormwater Design Guidelines with the following exceptions:

    a. The minimum longitudinal slope of channels (roadside ditches) shall be 0.6 % with a slope of 0.7% preferred.

    b. No low flow flumes shall be constructed in roadside ditches

    c. Roadside ditches may NOT be used for conveyance of increased flow from development regardless of timing analysis results.

    d. Side slopes on roadside ditches shall not exceed:

        (1.) 4:1 max on the front slope, and

        (2.) 3:1 max on the back slope.

601.03 Detention Facilities

1. All detention facilities shall be designed in accordance with the BCS Stormwater Design Guidelines.

601.04 Culverts

1. All culverts shall be designed in accordance with the TxDOT Hydraulic Manual.

601.05 Bridges

1. All bridge hydraulics shall be designed in accordance with the TxDOT Hydraulic Manual.

ARTICLE 7. WATER SERVICE (Domestic and Fire)

701. General

This section covers the design and construction of potable water distribution facilities including water mains, flushing valves, and service connections. In addition to these standards, all public drinking water systems will be provided in accordance with the current guidelines promulgated by the Texas Commission on Environmental Quality.

All potable water distribution systems shall be designed in accordance with the design guidelines for the respective certificated water provider for the property.

702. Water Service (Domestic and Fire)

1. Where an adequate supply of water is available, the installation of fire hydrants is required per Bryan/College Station Unified Design Guidelines. A water model showing that all fire hydrants can meet the required fire flow, velocity and pressure requirements as outlined in the BCS Unified Design Guidelines shall be submitted to the County Engineer.

2. Where there is not an adequate supply of water, the Brazos County Commissioner's Court requires a limited fire suppression system that requires a Developer to construct:

    a. For a Subdivision of fewer than fifty (50) houses, two thousand five hundred (2,500) gallons of storage; or

    b. For a Subdivision of fifty (50) or more houses, two thousand five hundred (2,500) gallons of storage with a centralized water system or five thousand (5,000) gallons of storage.

3. All Urban Subdivisions, as defined in the Brazos County Subdivision Regulations, must have access to a Public Water System for domestic supply and fire hydrant protection in accordance with the applicable municipality or Special Utility District regulations as determined by the County Engineer.

4. All Rural Subdivisions, as defined in the Brazos County Subdivision Regulations, must have access to either a Public Water System or provide Private Water Supply in accordance with Texas Local Government Code Section 232.0032 below:

    a. If a person submits a plat for the Subdivision of a tract of land for which the source of the water supply intended for the Subdivision is groundwater under that land, the Commissioners Court of a county by order may require the Plat Application to have attached to it a statement that:

        (1.) is prepared by an engineer licensed to practice in this state or a geoscientist licensed to practice in this state; and

(2.) certifies that adequate groundwater is available for the Subdivision for 50 years and approval by the Brazos Valley Groundwater Conservation District for the well.

b. The Texas Commission on Environmental Quality by rule shall establish the appropriate form and content of a certification to be attached to a Plat Application under this section.

c. The Texas Commission on Environmental Quality, in consultation with the Texas Water Development Board, by rule shall require a person who submits a plat under Subsection (a) to transmit to the Texas Water Development Board and any groundwater conservation district that includes in the district's boundaries any part of the Subdivision information that would be useful in:

(1.) performing groundwater conservation district activities;

(2.) conducting regional water planning;

(3.) maintaining the state's groundwater database; or

(4.) conducting studies for the state related to groundwater.

5. Water service to individual Lots shall be in accordance with BCS Unified Design Guidelines or applicable rural water supplier regulations.

703. Technical Design

1. All extensions of water mains shall be designed and constructed in accordance with the Bryan/College Station Unified Design Guidelines, Bryan/College Station Unified Technical Specifications, Bryan/College Station Unified Construction Details and all other applicable local, state, and federal requirements. In the case, where the certificated water provider is a Special Utility District all water mains shall be constructed in accordance with their design guidelines. Where there is a conflict of standards, the more stringent standard shall apply, as determined by the County Engineer. All designs must be prepared by a Licensed Professional Engineer in the State of Texas.

2. In the absence of a certificated water provider, all design shall be in accordance with TCEQ regulations.

3. The Engineer shall provide a letter of serviceability from an entity or entities providing water service or a letter stating that no service is available within 300 feet of the subdivision and certifying that the lots are suitable for private wells.

ARTICLE 8. SANITARY SEWER SERVICE

801. General

These standards for wastewater collection systems have been adopted to establish a criteria compatible with existing State statutes pertaining to effluent quality, and to provide facilities which will be designed in accordance with good public health and water quality engineering practices. In addition to these standards, all wastewater systems will be provided in accordance with current guidelines promulgated by the Texas Commission on Environmental Quality.

It will be the responsibility of the Engineer to submit to Brazos County all design reports required by TCEQ and/or the applicable municipality. Wastewater facilities will be designed considering the estimated contributing population to be served in the future. The peak flow of domestic sewage, peak flow of waste from industrial plants, peak flow for institutional and commercial flows shall be considered in determining capacities. Strict attention shall be given to minimizing infiltration/inflow into the system.

Onsite Sanitary Sewer Facilities (OSSF) installation and approvals shall be in accordance with Brazos County Health District and other regulatory authorities.

802. Sanitary Sewer Service

1. Rural Subdivisions, as defined in the Brazos County Subdivision Regulations, may have an OSSF systems. Urban Subdivisions, as defined in the Brazos County Subdivision Regulations, shall connect to an approved Public Sanitary Sewer System.

2. All Lots shall meet the minimum Lot size for the type of sanitary sewer service being used (OSSF vs. Public Collection System). For minimum lot sizes refer to the Brazos County Subdivision Regulations.

3. For determining the area required for an On-site Sewage Facility (OSSF), the minimum Lot size shall be in accordance with the current regulations of the Brazos County Health District or with the requirements of any other agency responsible for issuing permits for On-site sewage disposal as may be designated by the Brazos County Commissioner's Court.

803. Technical Design

1. For developments within a City ETJ that are an Urban Subdivision, as defined in the Brazos County Subdivision Regulations, all extensions of sewer mains shall be designed and constructed in accordance with the Bryan/College Station Unified Design Guidelines, Bryan/College Station Unified Technical Specifications, Bryan/College Station Unified Construction Details and all other applicable local, state, and federal requirements. Where there is a conflict of standards, the more stringent standard shall apply, as determined by the County Engineer.

2. For developments outside of a City ETJ that are an Urban Subdivision, as defined in the Brazos County Subdivision Regulations, all extensions of sewer mains shall be designed and constructed in accordance with the TCEQ regulations.

3. For any developments that are a Rural Subdivision, as defined in the Brazos County Subdivision Regulations, all sanitary sewer facilities shall be in accordance with the current regulations of the Brazos County Health District or with the requirements of any other agency responsible for issuing permits for On-site sewage disposal as may be designated by the Brazos County Commissioner's Court.

ARTICLE 9. DRIVEWAYS

901. Driveways

1. Urban Subdivision, as defined in the Brazos County Subdivision Regulations, driveway spacing shall be in accordance with the respective City site design regulations.

2. Rural Subdivision, as defined in the Brazos County Subdivision Regulations, driveway spacing shall be in accordance with Table 4.5.

3. Driveway entrances onto TxDOT facilities shall meet TxDOT driveway spacing criteria per TxDOT Access Management Manual.

4. Driveway entrances directly onto freeways, major and minor Arterial Roads are discouraged by the County.

5. The use of concrete "dip type" driveways is permissible. If a “dip type” driveway is utilized it must be a concrete driveway. The maximum grade break at each vertical point of intersection shall be 15%.

6. It is the County preference to provide asphalt driveway aprons if the adjacent roadway is also asphalt.

7. All concrete driveway aprons will be 3000 PSI with a minimum thickness of four inches. Minimum reinforcement steel shall be #3 bars at 18" on center each way (OCEW).

8. See Appendix B for a copy of the Brazos County Regulations for the Construction of Driveways and Culverts in County Easements and Rights and Way.

ARTICLE 10. DRIVEWAY CULVERTS

1001. Driveway Culverts

1. All driveway culverts require a Driveway Culvert permit from the County Engineer prior to installation.

2. Driveway culverts for all Lots shall be designed by an Engineer and shall be shown on a table on the plat. The table shall include the Lot number, culvert length, size and invert elevations. This information shall also be placed in the deed restrictions, if any, for the Lots in the Subdivision.

3. All driveway culverts shall be designed to handle drainage based upon a 10-year design storm.

4. All driveway culverts on arterial roadways shall include a safety end treatment per TxDOT specifications.

5. See Appendix B for a copy of the Brazos County Regulations for the Construction of Driveways and Culverts in County Easements and Rights and Way.

ARTICLE 11. EROSION AND SEDIMENT CONTROL

1101. General

1. Erosion and sediment control is important during the construction of any project in order to protect the carrying capacity of the overall drainage system. All requirements as stipulated by the Texas Commission on Environmental Quality (TCEQ) stormwater regulations shall be followed by the design Engineer and the Contractor. In addition, all erosion and sediment control measures shall be designed in accordance with the BCS Stormwater Design Guidelines.

ARTICLE 12. MAILBOXES

1201. Mailboxes

1. Rural mailboxes shall be set five (5) feet from the edge of the pavement or behind curbs, when used.

2. All mailboxes within county arterial right-of-way shall meet the current TxDOT standards. Any mailbox that does not meet this requirement may be removed by Brazos County.

3. Single-Family Residential properties that are exempt from platting must utilize mailboxes with a breakaway base and must be set five (5) feet from the edge of pavement.

4. All Rural Subdivisions, Urban Subdivisions, Multi-Unit Residential Developments or Manufactured Home Communities, created after July 5, 2016 shall use Neighbor Delivery and Collection Box Units ("NDCBUs"), or community mailboxes. If possible, these mailbox units should be installed on low volume intersecting roadways or on private property. Locations for the NDCBUs shall be shown on the construction Plans.

ARTICLE 13. VARIANCES

1301. Variances

1. The Commissioner's Court of Brazos County shall have the authority to grant Variances from these Regulations when the public interest or the requirements of justice demands relaxation of the strict requirements of the rules.

2. Any person who wishes to receive a Variance shall apply to the County Engineer. All Variance request shall be submitted in writing to the County Engineer. The request must state the provisions to which a Variance is being sought while illustrating the necessity for the Variance. It must be further shown that the Variance will not create adverse impacts to the public interest.

3. The decision of the Commissioner's Court whether to grant or deny a Variance is at its complete discretion, and shall be final.

4. No Variance shall be granted regarding bonding.

5. Financial hardship to the Applicant shall not be deemed sufficient reason to constitute the recommendation of a Variance.

ARTICLE 14. PENALTIES

1401. Penalties

1. Section 232.005 of the Texas Local Government Code provides for the enforcement of the State Subdivision laws and of these Regulations.

2. A person commits an offense if the person knowingly or intentionally violates a requirement of these Regulations, including the BCEDG and other Appendices incorporated herein. Such offense is a Class B misdemeanor, as defined in the Texas Local Government Code as amended.

3. Under Texas Law, a person may be jointly responsible as a party to an offense if the person (acting with intent to promote or assist the commission of the offense) solicits, encourages, directs, aids, or attempts to aid another person to commit the offense. Thus, a real estate agent or broker, a lender, an attorney, a surveyor, an Engineer, a title insurer, or any other person who assists in violating these Regulations may also face criminal penalties.

4. Besides prosecuting a criminal complaint, the County Attorney or other prosecuting attorney for the County may file a civil action in a court of competent jurisdiction to enjoin any violation or threatened violation of these Regulations, and to recover damages.

5. A tract that has been subdivided without compliance with these Regulations will be ineligible to obtain a permit for the construction or modification of a private sewage facility located on the tract.

Appendix A

Appendix A: Alternate Pavement Design

Pavement Design Standards

1. General: In determining the required pavement strengths, the following factors shall be considered:

    a. Road designation

    b. Traffic Data. DHV, ADT, Percent Trucks (T)

    c. Soil characteristics and strength

    d. Traffic growth rates

    e. Pavement strengths

    f. Structural number

    g. Stage development

    h. Parking

    i. Drainage

    j. Geometrics

2. Road Designation: A road's designation as Rural, Residential, Collector, Local Commercial, Industrial Service or Arterial, should be determined in consultation with the County Engineers Office.

3. Traffic Data: The following information shall be provided for each proposed road improvement:

    a. ADT, Average Daily Traffic, the daily traffic flow in both directions of travel, for a 24 hour period.

    b. DHV, Design Hour Volume, the 30th highest hourly volume of the year is designated the DHV. If this information is not readily available DHV may be calculated as 12% of the ADT.

    c. T, Percentage of Trucks, the quantity of trucks during the ADT or DHV, expressed a percent of that total traffic. For the purpose here, light delivery trucks, such as panels and pickups, are considered as passenger cars. In lieu of the actual field data, T can be considered 10% on

Arterials, 5% on collector and minor Residential. Special conditions must be discussed with the County Engineer for the Industrial Pro Designations.

(1.) Trucks shall be further identified as follows, during the traffic counting:

(a.) 2DT – Unit truck, two axles

(b.) 3SU – Unit truck, three axles

(c.) 2S1 – Semi truck, two axles on cab, two axles on trailer

(d.) 2S2 – Semi truck, two axles on cab, two axles on trailer

(e.) 2AX – Truck with five axles or more

4. Subgrade Soil Support Value

    a. In the case of proposed new construction, the soil support value of the Subgrade will be provided by the tri-axial shear test; modulus of deformation may be developed by laboratory testing and correlated with the accompanying soil support scale to provide these data.

5. Traffic Growth Rate

    a. A figure of 4% per year has been identified as the growth rate characterizing traffic within the United States. This figure should be used for forecasting anticipated ADT with the pavement design life. Other figures from local expertise (such as MPO or City Traffic Departments) are acceptable, when qualified as acceptable by the County Engineer.

6. Coefficients of Relative Strength of Pavement Component Layers

    a. Are provided in Table 12 below. It is to be understood that these coefficients may change if and when future studies are made to accurately evaluate their respective tensile strength. At that time the County Engineer will provide updated coefficients for incorporation with these standards.

7. Structural Number

    a. An index number derived from an analysis of traffic and design features which may be converted to pavement thickness through the use of suitable factors related to the type of material being used in the pavement structure.

    b. This dimensionless number reflects the product of the necessary thickness of the various road building components of pavement, i.e., sub-base, base-course, binder and /or leveling course,

surface course and existing surface course, and their respective Coefficient of Relative Strength which when totaled together for final pavement design must equal or exceed the Structural Number (SN).

c. The designer should be aware that the minimum structural number for the particular road designations are shown in Tables below.

d. These minimum structural numbers are applicable to roads constructed on subgrades of soil types shown in the following tables.

8. Stage Construction

a. Various items of road construction such as pavement courses, lane requirements of for future traffic volume, or other sequential work must have the approval of the County Engineer prior to consideration for acceptance by Brazos County.

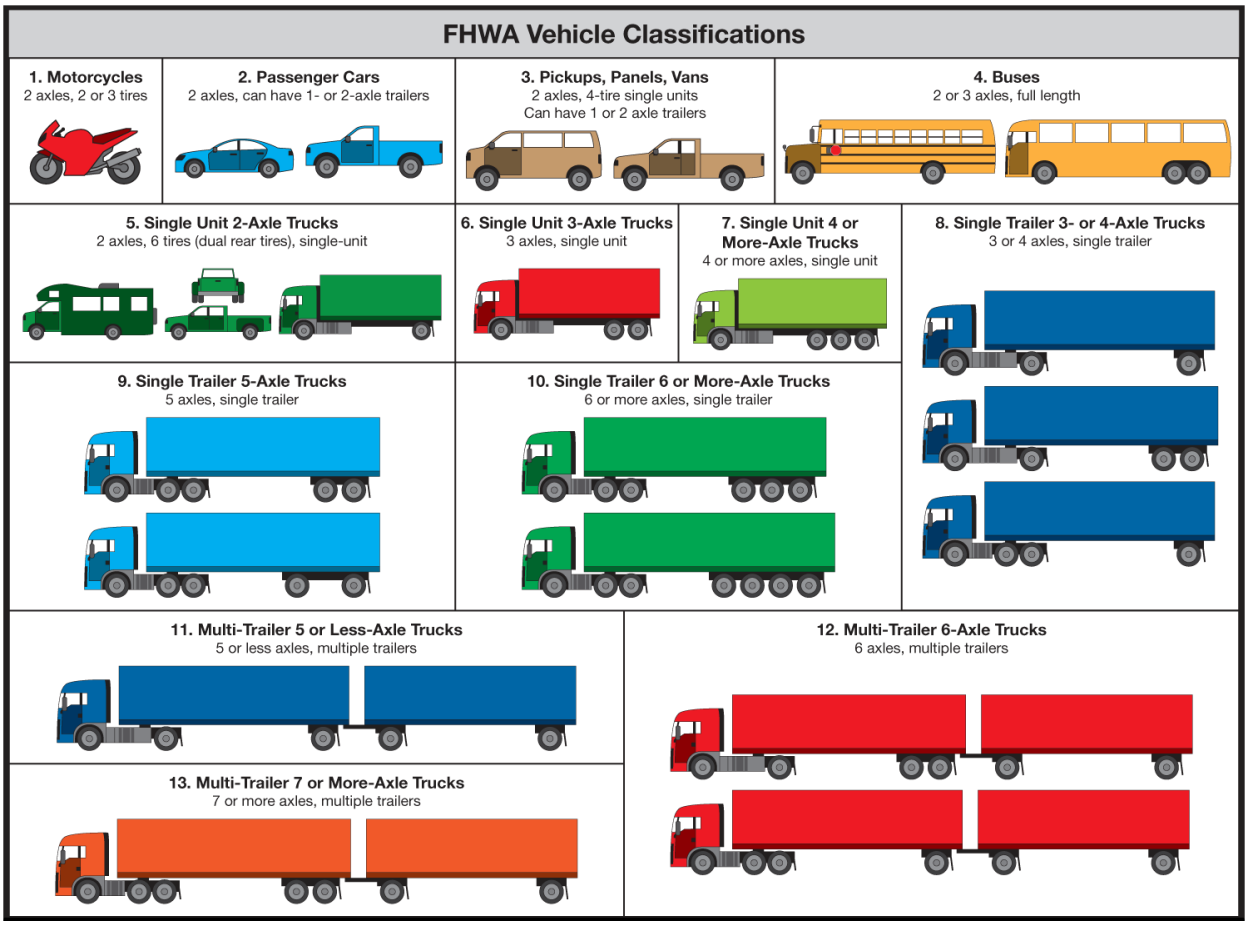
Table 1. Equivalent Soil Types in Terms of Strength and Typical CBR and Resilient Modulus Range (NCHRP, 2001)

USCS Soil Type(s) [Note 1]	Equivalent AASHTO Soil Type(s) in Terms of Strength [Note 2]	Typical CBR Range [Note 3 & 4]	Typical Resilient Modulus Range (psi) [Note 5]
CH	A-7-6	1 – 5	2,500 – 7,100
MH	A-7-5	2 – 8	3,900 – 9,600
CL	A-6	5 – 15	7,100 – 14,400
ML	A-5	8 – 16	9,600 – 15,000
SC	A-4 and A-2-7	10 – 20	11,100 – 17,300
SW-SC and SP-SC	A-2-6	10 – 25	11,100 – 20,000
SP, SP-SM, and SW-SM	A-2-5	15 – 30	14,400 – 22,500
--	A-3	15 – 35	14,400 – 24,800
SW and SM	A-2-4	20 – 40	17,300 – 27,000

Notes:

1. Unified Soil Classification System (USCS). Group symbol determined in accordance with ASTM D2487-11 – *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*.
2. American Association of State Highway and Transportation Officials (AASHTO). Group symbol determined in accordance with ASTM D3282-15 – *Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes*.
3. California Bearing Ratio (CBR).
4. Typical CBR ranges referenced from Appendix CC-1: *Correlations of CBR Values with Soil Index Properties* of the *2001 Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures*.
5. Typical resilient modulus range (M_R) was computed using the following relationship: $M_R = 2555(CBR)^{0.64}$. Presented values were rounded down to the nearest hundred.

Figure 1 – Federal Highway Administration (FHWA) Vehicle Classifications (TxDOT, 2012)



Notes:

1. Light weight vehicles (FHWA Class 1 through Class 3).
2. Medium-weight trucks (FHWA Class 4 through Class 7).
3. Heavy-weight trucks (FHWA Class 8 through Class 10).
4. Very heavy-weight trucks (FHWA Class 11 through 13).

Table 2. Assumed Traffic Information for Rural-Privately Maintained Roadways (Type E Roadways)

Street Classification	Average Daily Traffic (ADT) (Total Vehicles per Day, 2-Way Traffic)	Percent Trucks (%) of ADT		Design Equivalent Single Axle Loads (ESALs) Notes 1 and 2
		% Medium-Weight Trucks Note 3	% Heavy-Weight Trucks Note 4	
Type E1 (low volume)	100	1.5	0.5	5,000
Type E2 (moderate volume)	250	1.5	0.5	15,000
Type E3 (high volume)	500	1.5	0.5	25,000

Notes:

1. Design equivalent single axle loads (ESALs) were computed under the assumption that the average daily traffic (ADT) is split evenly between the two (2) directions of travel. A lane distribution factor was not considered for ESALs calculations. Therefore, the design lane was assumed to carry half of the ADT.
2. A 20-year design period was assumed to calculate the design ESALs. A growth rate was not considered for ESAL computations.
3. Medium-weight trucks are defined as single-unit or single frame trucks such as delivery trucks and buses. These vehicles can also be defined in terms of Federal Highway Administration (FHWA) category classification. Medium-weight trucks are considered to fall under FHWA vehicle classes 4, 5, 6, and 7.
4. Heavy-weight trucks are defined as double-weight or double-frame trucks such as tractor-trailers and semi-trailers. These vehicles can also be defined in terms of FHWA category class. Heavy-weight trucks are considered to fall under FHWA vehicle classes 8, 9, and 10.

Table 3. Minimum Design Pavement Sections for Type E Street Classifications Based on Variable USCS Subgrade Soil Types

Street Classification	USCS Group Symbol [Note 1]	Minimum Aggregate-Surface Thickness (inches) [Note 3, 4, & 5]
Type E1 (low volume)	CH	6.0 (See Note 2 Below)
	CL	6.0 (See Note 2 Below)
	SC	6.0 (See Note 2 Below)
Type E2 (moderate volume)	CH	6.0 (See Note 2 Below)
	CL	6.0 (See Note 2 Below)
	SC	6.0 (See Note 2 Below)
Type E3 (high volume)	CH	8.0
	CL	7.0
	SC	6.0 (See Note 2 Below)

Notes:

1. Equivalent AASHTO soil types can be obtained in Table 1 – *Equivalent Soil Types in Terms of Strength and Typical CBR and Resilient Modulus Range (NCHRP, 2001)*.
2. Minimum aggregate-surface thicknesses were determined in accordance with Chapter 4 – *Low-Volume Road* Design; Section 4.1.2 – *Aggregate-Surface Roads* of the 1993 AASHTO *Guide for Design of Pavement Structures*.
3. The minimum aggregate-surface thickness shall not be less than 6 inches.
4. A minimum subbase or chemically stabilized and compacted subgrade layer of 8 inches should be used to construct each aggregate-surface pavement section.

Table 4. Assumed Traffic Information for Rural-Publicly Maintained Roadways (Type A Roadways); Urban-Publicly Maintained Roadways (Type B Roadways; Commercial; and Industrial Roadways

Street Classification	Average Daily Traffic (ADT) (Total Vehicles per Day, 2-Way Traffic)	Percent Trucks (%) of ADT		Design Equivalent Single Axle Loads (ESALs) Notes 1 and 2	
		% Medium-Weight Trucks Note 3	% Heavy-Weight Trucks Note 4	Flexible Pavement	Rigid Pavement
Type A (Residential)	1,500	3.0	1.0	125,000	280,000
Type A (Minor Collector)	3,000	5.0	1.5	390,000	870,000
Type B (Residential)	3,000	3.0	1.0	250,000	550,000
Type B (Minor Collector)	5,000	5.0	1.5	640,000	1,500,000
Commercial (Minor Collector)	5,000	10.0	2.0	1,100,00	2,500,000
Industrial (Minor Collector)	3,000	8.0	5.0	900,000	2,100,000

Notes:

1. Design ESALs were computed under that assumption that the average daily traffic is split evenly between the two directions of travel. A lane distribution factor was not considered. Therefore, the design lane was assumed to carry half of the average daily traffic.
2. A 20-year design period was assumed to calculate the design ESALs for flexible pavement sections; whereas a 30-year design period was assumed to calculate the design ESALs for rigid pavement sections. A growth rate was not considered for any of the street classifications.
3. Medium-weight trucks are defined as single-unit or single frame trucks such as delivery trucks and buses. These vehicles can also be defined in terms of Federal Highway Administration (FHWA) 13 category classification. Medium-weight trucks are considered to fall under FHWA vehicle classes 4, 5, 6, and 7.
4. Heavy-weight trucks are defined as double-unit or double-frame trucks such as tractor-trailers and semi-trailers. These vehicles can also be defined in terms of Federal Highway Administration (FHWA) 13 category classification. Heavy-weight trucks are considered to fall under FHWA vehicle classes 8, 9, and 10.

Table 5. Minimum Design Flexible Pavement Sections for Type A Street Classifications (Residential and Minor Collector Roadways) Based on Variable Subgrade Classifications and a Chip Seal Surface Treatment

Street Classification	Sub-Classification	USCS Group Symbol	Minimum Pavement Layer Thickness (inches)	Total Structural Number (Required Total Structural Number) Note 4
Type A	Residential Note 5	CH	Chip Seal Surface Treatment D_2 = Flexible Base Layer Thickness = 14.0" D_3 = Subbase Layer Thickness = 8.0"	2.60 (2.50)
		CL	Chip Seal Surface Treatment D_2 = Flexible Base Layer Thickness = 12.0" D_3 = Subbase Layer Thickness = 8.0"	2.32 (2.21)
		SC	Chip Seal Surface Treatment D_2 = Flexible Base Layer Thickness = 9.0" D_3 = Subbase Layer Thickness = 8.0"	1.90 (1.86)
	Minor Collector Note 6	CH	Chip Seal Surface Treatment D_2 = Flexible Base Layer Thickness = 20.0" D_3 = Subbase Layer Thickness = 8.0"	3.44 (3.31)
		CL	Chip Seal Surface Treatment D_2 = Flexible Base Layer Thickness = 17.0" D_3 = Subbase Layer Thickness = 8.0"	3.02 (2.93)
		SC	Chip Seal Surface Treatment D_2 = Subbase Layer Thickness = 14.0" D_3 = Subbase Layer Thickness = 8.0"	2.60 (2.48)

See Notes on Page 76

Notes (Table 5):

1. Surface Treatment (Chip-Seal), Flexible Base Layer (TxDOT Item 247, Type A, Grade 1-2), and Subbase Layer (Lime Stabilized and Compacted Subgrade).
2. The chip-seal surface treatment was not considered as a structural layer in the flexible pavement sections. Chip-seal surface treatment does not increase the structural capacity of a flexible pavement section. The chip-seal is predominately using to improve a roadways resistance to environmental factors.
3. A minimum subbase layer of 8 inches should be used. Under no circumstance shall the thickness of the subbase layer be reduced. The subbase layer may be increased; however, an 8-inch thick layer should be used to determine the total structural number of the pavement section.
4. Structural layer coefficients used in calculations were 0.44 for HMAC, 0.14 for flexible base, and 0.08 for stabilized subgrade.
5. Summary of other design inputs for residential roadways: S_o = 0.49, R = 70%, P_i = 4.2, and P_i = 2.0.
6. Summary of other design inputs for minor collector roadways: S_o = 0.49, R = 85%, P_i = 4.2, and P_i = 2.25.

Table 6. Minimum Design Flexible Pavement Sections for Type B Street Classifications (Residential and Minor Collector Roadways) Based on Variable Subgrade Classifications and a Chip Seal Surface Treatment

Street Classification	Sub-Classification	USCS Group Symbol	Minimum Pavement Layer Thickness (inches)	Total Structural Number (Required Total Structural Number) Note 4
Type B	Residential Note 5	CH	Chip Seal Surface Treatment D_2 = Flexible Base Layer Thickness = 16.0" D_3 = Subbase Layer Thickness = 8.0"	2.88 (2.85)
		CL	Chip Seal Surface Treatment D_2 = Flexible Base Layer Thickness = 14.0" D_3 = Subbase Layer Thickness = 8.0"	2.60 (2.53)
		SC	Chip Seal Surface Treatment D_2 = Flexible Base Layer Thickness = 11.0" D_3 = Subbase Layer Thickness = 8.0"	2.18 (2.14)
	Minor Collector Note 6	CH	Chip Seal Surface Treatment D_2 = Flexible Base Layer Thickness = 23.0" D_3 = Subbase Layer Thickness = 8.0"	3.86 (3.73)
		CL	Chip Seal Surface Treatment D_2 = Flexible Base Layer Thickness = 20.0" D_3 = Subbase Layer Thickness = 8.0"	3.44 (3.31)
		SC	Chip Seal Surface Treatment D_2 = Subbase Layer Thickness = 16.0" D_3 = Subbase Layer Thickness = 8.0"	2.88 (2.80)

See Notes on Page 78

Notes (Table 6):

1. Surface Treatment (Chip-Seal), Flexible Base Layer (TxDOT Item 247, Type A, Grade 1-2), and Subbase Layer (Lime Stabilized and Compacted Subgrade).
2. The chip-seal surface treatment was not considered as a structural layer in the flexible pavement sections. Chip-seal surface treatment does not increase the structural capacity of a flexible pavement section. The chip-seal is predominately using to improve a roadways resistance to environmental factors.
3. A minimum subbase layer of 8 inches should be used. Under no circumstance shall the thickness of the subbase layer be reduced. The subbase layer may be increased; however, an 8-inch thick layer should be used to determine the total structural number of the pavement section.
4. Structural layer coefficients used in calculations were 0.44 for HMAC, 0.14 for flexible base, and 0.08 for stabilized subgrade.
5. Summary of other design inputs for residential roadways: S_o = 0.49, R = 75%, P_i = 4.2, and P_i = 2.0.
6. Summary of other design inputs for minor collector roadways: S_o = 0.49, R = 90%, P_i = 4.2, and P_i = 2.25.

Table 7. Minimum Design Flexible Pavement Sections for Type A Street Classifications (Residential and Minor Collector Roadways) Based on Variable Subgrade Classifications and a HMAC Surface Course

Street Classification	Sub-Classification	USCS Group Symbol	Minimum Pavement Layer Thickness (inches)	Total Structural Number (Required Total Structural Number) Note 4
Type A	Residential Note 5	CH	D_1 = Surface Layer Thickness = 2.0"	2.50 (2.50)
			D_2 = Flexible Base Layer Thickness = 7.0"	
			D_3 = Subbase Layer Thickness = 8.0"	
		CL	D_1 = Surface Layer Thickness = 2.0"	2.36 (2.21)
			D_2* = Flexible Base Layer Thickness = 6.0"	
			D_3 = Subbase Layer Thickness = 8.0"	
		SC	D_1 = Surface Layer Thickness = 2.0"	2.36 (1.86)
			D_2* = Flexible Base Layer Thickness = 6.0"	
			D_3 = Subbase Layer Thickness = 8.0"	
	Minor Collector Note 6	CH	D_1 = Surface Layer Thickness = 2.5"	3.42 (3.31)
			D_2 = Flexible Base Layer Thickness = 12.0"	
			D_3 = Subbase Layer Thickness = 8.0"	
		CL	D_1 = Surface Layer Thickness = 2.5"	3.00 (2.93)
			D_2 = Flexible Base Layer Thickness = 9.0"	
			D_3 = Subbase Layer Thickness = 8.0"	
		SC	D_1 = Surface Layer Thickness = 2.5"	2.58 (2.48)
			D_2 = Subbase Layer Thickness = 6.0"	
			D_3 = Subbase Layer Thickness = 8.0"	

See Notes on Page 80

Notes (Table 7):

1. Surface Layer (Hot-Mix Asphalt Concrete – TxDOT Item 340, Type D), Flexible Base Layer (TxDOT Item 247, Type A, Grade 1-2), and Subbase Layer (Lime Stabilized and Compacted Subgrade).
2. The minimum surface layer or HMAC thickness shall not be less than that indicated for each minimum design section.
3. A minimum subbase or chemically stabilized and compacted subgrade layer of 8 inches should be used. Under no circumstance shall the thickness of the subbase layer be reduced. The subbase layer may be increased; however, an 8-inch thick layer should be used to determine the total structural number of the pavement section.
4. Structural layer coefficients used in calculations were 0.44 for HMAC, 0.14 for flexible base, and 0.08 for stabilized subgrade.
5. Summary of other design inputs for residential roadways: S_o = 0.49, R = 70%, P_i = 4.2, and P_i = 2.0.
6. Summary of other design inputs for minor collector roadways: S_o = 0.49, R = 85%, P_i = 4.2, and P_i = 2.25.
7. (*) Indicates that required minimum flexible base layer thickness is less than 6 inches; however, a minimum base layer of 6 inches is required (see note 3)

Table 8. Minimum Design Flexible Pavement Sections for Type B Street Classifications (Residential and Minor Collector Roadways) Based on Variable Subgrade Classifications and a HMAC Surface Course

Street Classification	Sub-Classification	USCS Group Symbol	Minimum Pavement Layer Thickness (inches)	Total Structural Number (Required Total Structural Number) Note 4
Type B	Residential Note 5	CH	D_1 = Surface Layer Thickness = 2.0"	2.92 (2.85)
			D_2 = Flexible Base Layer Thickness = 10.0"	
			D_3 = Subbase Layer Thickness = 8.0"	
		CL	D_1 = Surface Layer Thickness = 2.0"	2.64 (2.53)
			D_2 = Flexible Base Layer Thickness = 8.0"	
			D_3 = Subbase Layer Thickness = 8.0"	
		SC	D_1 = Surface Layer Thickness = 2.0"	2.36 (2.14)
			D_2* = Flexible Base Layer Thickness = 6.0"	
			D_3 = Subbase Layer Thickness = 8.0"	
	Minor Collector Note 6	CH	D_1 = Surface Layer Thickness = 3.0"	3.78 (3.73)
			D_2 = Flexible Base Layer Thickness = 13.0"	
			D_3 = Subbase Layer Thickness = 8.0"	
		CL	D_1 = Surface Layer Thickness = 3.0"	3.36 (3.31)
			D_2 = Flexible Base Layer Thickness = 10.0"	
			D_3 = Subbase Layer Thickness = 8.0"	
		SC	D_1 = Surface Layer Thickness = 3.0"	2.80 (2.80)
			D_2 = Subbase Layer Thickness = 6.0"	
			D_3 = Subbase Layer Thickness = 8.0"	

See Notes on Page 82

Notes (Table 8):

1. Surface Layer (Hot-Mix Asphalt Concrete – TxDOT Item 340, Type D), Flexible Base Layer (TxDOT Item 247, Type A, Grade 1-2), and Subbase Layer (Lime Stabilized and Compacted Subgrade).
2. The minimum surface layer or HMAC thickness shall not be less than that indicated for each minimum design section.
3. A minimum subbase or chemically stabilized and compacted subgrade layer of 8 inches should be used. Under no circumstance shall the thickness of the subbase layer be reduced. The subbase layer may be increased; however, an 8-inch thick layer should be used to determine the total structural number of the pavement section.
4. Structural layer coefficients used in calculations were 0.44 for HMAC, 0.14 for flexible base, and 0.08 for stabilized subgrade.
5. Summary of other design inputs for residential roadways: S_o = 0.49, R = 75%, P_i = 4.2, and P_i = 2.0.
6. Summary of other design inputs for minor collector roadways: S_o = 0.49, R = 90%, P_i = 4.2, and P_i = 2.25.
7. (*) Indicates that required minimum flexible base layer thickness is less than 6 inches; however, a minimum base layer of 6 inches is required (see note 3)

Table 9. Minimum Design Flexible Pavement Sections for Commercial and Industrial Roadways (Collector Roadways) Based on Variable Subgrade Classifications and a HMAC Surface Course

Roadway Classification	Sub-Classification	USCS Group Symbol	Minimum Pavement Layer Thickness (inches)	Total Structural Number (Required Total Structural Number) Note 4
Collector	Commercial Note 5	CH	D_1 = Surface Layer Thickness = 3.5" D_2 = Flexible Base Layer Thickness = 15.0" D_3 = Subbase Layer Thickness = 8.0"	4.28 (4.18)
		CL	D_1 = Surface Layer Thickness = 3.5" D_2 = Flexible Base Layer Thickness = 11.0" D_3 = Subbase Layer Thickness = 8.0"	3.72 (3.70)
		SC	D_1 = Surface Layer Thickness = 3.5" D_2* = Flexible Base Layer Thickness = 7.0" D_3 = Subbase Layer Thickness = 8.0"	3.16 (3.11)
	Industrial Note 6	CH	D_1 = Surface Layer Thickness = 3.0" D_2 = Flexible Base Layer Thickness = 15.0" D_3 = Subbase Layer Thickness = 8.0"	4.06 (4.05)
		CL	D_1 = Surface Layer Thickness = 3.0" D_2 = Flexible Base Layer Thickness = 12.0" D_3 = Subbase Layer Thickness = 8.0"	3.64 (3.58)
		SC	D_1 = Surface Layer Thickness = 3.0" D_2 = Subbase Layer Thickness = 8.0" D_3 = Subbase Layer Thickness = 8.0"	3.08 (3.01)

See Notes on Page 84

Notes (Table 9):

1. Surface Layer (Hot-Mix Asphalt Concrete – TxDOT Item 340, Type D), Flexible Base Layer (TxDOT Item 247, Type A, Grade 1-2), and Subbase Layer (Lime Stabilized and Compacted Subgrade).
2. The minimum surface layer or HMAC thickness shall not be less than that indicated for each minimum design section.
3. A minimum subbase or chemically stabilized and compacted subgrade layer of 8 inches should be used. Under no circumstance shall the thickness of the subbase layer be reduced. The subbase layer may be increased; however, an 8-inch thick layer should be used to determine the total structural number of the pavement section.
4. Structural layer coefficients used in calculations were 0.44 for HMAC, 0.14 for flexible base, and 0.08 for stabilized subgrade.
5. Summary of other design inputs for commercial roadways: S_o = 0.49, R = 90%, P_i = 4.2, and P_i = 2.5.
6. Summary of other design inputs for industrial roadways: S_o = 0.49, R = 90%, P_i = 4.2, and P_i = 2.5.
7. (*) Indicates that required minimum flexible base layer thickness is less than 6 inches; however, a minimum base layer of 6 inches is required (see note 3)

Table 10. Minimum Design Rigid Pavement Sections for Type A Street Classifications (Residential and Minor Collector Roadways) Based on Variable Subgrade Classifications

Street Classification	Sub-Classification	USCS Group Symbol	Minimum Pavement Structure (inches)
Type A	Residential [Note 3]	CH	6.0
		CL	6.0
		SC	6.0
	Minor Collector [Note 4]	CH	7.0
		CL	7.0
		SC	6.0

Notes:

1. Rigid pavement section is assumed to be founded on an 8-inch lime stabilized and compacted subgrade.
2. A minimum rigid pavement section of 6 inches is required for any roadway subjected to truck traffic regardless of the computed thickness.
3. Summary of other design inputs for commercial roadways: S_o = 0.39, R = 70%, P_i = 4.5, P_i = 2.0, J = 2.9, and f'_c = 3,500 psi.
4. Summary of other design inputs for industrial roadways: S_o = 0.39, R = 85%, P_i = 4.5, P_i = 2.25, J = 2.9, and f'_c = 3,500 psi.

Table 11. Minimum Design Rigid Pavement Sections for Type B Street Classifications (Residential and Minor Collector Roadways) Based on Variable Subgrade Classifications

Street Classification	Sub-Classification	USCS Group Symbol	Minimum Pavement Structure (inches)
Collector	Commercial Note 3	CH	9.0
		CL	9.0
		SC	8.0
	Industrial Note 4	CH	9.0
		CL	9.0
		SC	8.0

Notes:

1. Rigid pavement section is assumed to be founded on an 8-inch lime stabilized and compacted subgrade.
2. A minimum rigid pavement section of 6 inches is required for any roadway subjected to truck traffic regardless of the computed thickness.
3. Summary of other design inputs for commercial roadways: S_o = 0.39, R = 90%, P_i = 4.5, P_i = 2.5, J = 2.9, and f'_c = 3,500 psi.
4. Summary of other design inputs for industrial roadways: S_o = 0.39, R = 90%, P_i = 4.5, P_i = 2.5, J = 2.9, and f'_c = 3,500 psi.

Table 12. Structural Layer Coefficients for Flexible Pavement Design

Description	Suggested AASHTO Structural Layer Coefficients
New Pavement Materials	
TxDOT Item 340, HMAC Type D	0.44
TxDOT Item 340, HMAC Type C	0.40 – 0.44
TxDOT Item 340, HMAC Type B	0.30 – 0.35
Emulsified Asphalt Treated Base	0.25 – 0.30
Cement-Treated Base	0.15 – 0.23
Flexible Base	0.12 – 0.16
Cement Stabilized Subgrade	0.12 – 0.14
Select Fill	0.06 – 0.08
Lime Stabilized Subgrade	0.06 – 0.10
Recycled Pavement Materials	
Reclaimed Flexible Base (with 30 percent or less recycled asphalt pavement (RAP))	0.11 – 0.14
Reclaimed Flexible Base (with more than 30 percent recycled asphalt pavement (RAP))	0.08 – 0.11
Reclaimed Base, Cement Stabilized	0.15 – 0.23

Notes:

1. Layer coefficients are affected by material properties, as well as the location of the layer in which the material is used.

Appendix B

Appendix B: Brazos County Design Regulations for the Construction of Driveways and Culverts in County Easements and Rights-of-Way

Appendix C

Appendix C: Hydrology Computational Information

Table C-1

Runoff Velocities (v) for Determining Time of Concentration (t_c)[1]

Reach Description	Slope of Reach			
	0 to 3%	4 to 7%	8 to 11%	>12%
	v *	v *	v *	v *
Overland or Sheet Flow				
Natural Woodlands	0-1.5	1.5-2.5	2.5-3.25	>3.25
Natural Grasslands	0-2.5	2.5-3.5	3.5-4.25	>4.25
Landscaped Areas	0-3.0	3.0-4.5	4.5-5.5	>5.5
Pavements	0-8.5	8.5-13.5	13.5-17.0	>17.0
Concentrated Flow				
Natural Channels	0-2.0	2.0-4.0	4.0-7.0	>7.0
Street or Gutter Flow	Use procedure in Section VI, Paragraphs A & B of the BCS Unified Design Guidelines			
Storm Sewer	Use procedure in Section VI, Paragraph C of the BCS Unified Design Guidelines			
Open Channels (designed)	Use procedure in Section VI, Paragraph D of the BCS Unified Design Guidelines			
*Note: "v" in feet per second				

[1] From the "Hydraulic Design Manual" of the Texas Department of Transportation, 2002

Table C-2

Manning's Roughness Coefficients for Sheet Flow (n)

Description of Surface	Roughness Coefficient (n)
Smooth Surfaces (concrete, asphalt, gravel or bare soil)	0.011
Cultivated Soils	
Fallow (no residue)	0.050
Residue Cover (less than 20%)	0.060
Residue Cover (greater than 20%)	0.170
Grass	
Short grass prairie	0.150
Dense grass prairie	0.240
Bermuda grass	0.410
Range (natural)	0.130
Woods	
Light Underbrush	0.400
Dense Underbrush	0.800

Source: After U.S. Department of Agriculture (1986).

Table C-3

Depth-Duration-Interval Data (TP-40 and Hydro 35)

Storm Duration	Rainfall Depth for Duration and Storm Recurrence Interval (inches)						
	2-year	5-year	10-year	25-year	50-year	100-year	USGS 500-year
5-min	0.53	0.60	0.66	0.75	0.82	0.89	--
15-min	1.15	1.33	1.46	1.66	1.82	1.98	3.0
30-min	1.68	2.00	2.24	2.59	2.87	3.14	3.6
60-min	2.20	2.68	3.02	3.52	3.91	4.30	5.8
2-hr	2.60	3.36	3.94	4.57	5.10	5.60	8.3
3-hr	2.86	3.70	4.41	5.14	5.65	6.30	9.0
6-hr	3.33	4.41	5.29	6.20	6.95	7.90	11.0
12-hr	3.80	5.25	6.28	7.42	8.45	9.50	12.5
24-hr	4.50	6.20	7.40	8.40	9.80	11.00	14.0

Source: Combination of Soil Conservation Service TP 40 and Hydro 35